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A Revision of the Indian Ixodidae with special reference to the collection in the Indian Museum.

By
M. SHARIF.

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A REVISION OF THE INDIAN IXODIDAE WITH SPECIAL REFERENCE TO THE COLLECTION IN THE INDIAN MUSEUM.

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(Plates VIII, IX).

CONTENTS.

INTRODUCTION.

The importance of ticks as disease carriers in man and domesticated animals has made their study very popular with parasitologists in other countries, but in India they have, so far, not received the attention they deserve. The tick fauna of India is very rich in the number of both genera and species, but most of the Indian species are poorly described and insufficiently illustrated. The only up to date account of ticks is that of Nuttall, Warburton, Robinson and Cooper (1908-1926), but this work is still incomplete, and the descriptions of many of the Indian forms are far from adequate. In this paper I have attempted to amplify the descriptions of the Indian species that have been dealt with by the authors mentioned above and have redescribed other forms which occur in India but have not so far been dealt with by these authors. Some of the rarer Indian species described or recorded by previous workers, which I have had no opportunity of examining, are not considered in detail, but are only included in the analytical keys of the species.

Most of the collections dealt with in this paper belong to the Zoological Survey of India (Indian Museum), Calcutta. Some of this material has been collected from time to time by the officers of the Zoological Survey, but a greater part of it has been got together during the last year through a circular sent at my request by Lt.-Col. R. B. Seymour Sewell, Director,

Zoological Survey of India, to the heads of the Civil Veterinary Departments in the various provinces of India requesting them to arrange for ticks to be especially collected for me. The heads of the Civil Veterinary Departments in Bihar and Orissa and the Central Provinces took considerable trouble in getting the specimens collected; in fact half of the material on which I have worked is from these provinces. For all this I owe them my best thanks. I am also grateful to the heads of the Civil Veterinary Departments in other provinces of India for their help in getting collections made in the areas under their jurisdiction. The material belonging to the Imperial Agricultural Research Institute, Pusa, was placed at my disposal through the courtesy of Mr. M. A. Hussain, the then Officiating Imperial Entomologist; the specimens contained in this collection are indicated by the words "Pusa Coll." Dr. C. Strickland, Professor of Entomology, Calcutta School of Tropical Medicine and Hygiene, has also kindly lent me the collection of ticks belonging to his institution; the specimens contained in this collection are indicated by the letters "C. S. T. M. Coll." Specimens belonging to the Central Research Institute, Kasauli, are indicated by the words "Kasauli Coll." and those belonging to the Imperial Veterinary Research Institute, Muktesar, by "Muktesar Coll." Dr. Sundra Rao, Darbhanga Scholar for Filariasis Research, Calcutta School of Tropical Medicine and Hygiene, has presented to the Indian Museum numerous specimens of ticks collected by him in the Naini-Tal District and identified by Mr. Warburton. For these I am especially obliged to him.

I am greatly indebted to Lt.-Col. R. B. Seymour Sewell for the interest he has taken in my work and for revising my manuscript. I also tender my best thanks to my colleagues in the Zoological Survey of India, Drs. S. L. Hora and B. N. Chopra and Mr. S. Ribeiro for the generous aid they have given me throughout my work.

The text-figures illustrating this paper are taken from camera-lucida drawings and, with the exception of a few, were finished from my pencil sketches by Babu Subodh Mondul, who with Babu D. N. Bagchi also prepared the plates accompanying the paper. Text-figs. 3, 4, 20 and 21 were prepared by Babu A. C. Chowdhury and myself. I am thankful to these artists of the Zoological Survey of India for the care they have taken in making true and faithful delineations of the specimens.

In working on the Indian ticks I have had the advantage of having before me those collections in the Indian Museum that had already been identified by Dr. G. H. F. Nuttall, Dr. L. E. Robinson and Mr. C. Warburton.

In almost all cases I have given analytical keys to facilitate the identification of the Indian genera and species. The bibliography at the end includes only those references which are not included in the two volumes of the Bibliography of the Ixodidae by Nuttall, Cooper and Robinson (1911, 1915), while the few publications dealing with ticks which I have not been able to consult are marked with an asterisk(*).

In the account of the geographical distribution of the various species I have given the general range of their distribution and have also given a detailed list of localities from which they have been recorded in India.

The life-history and bionomics of most of the Indian species are as yet unknown and I would draw the special attention of other workers to this line of research. Veterinary Surgeons having a little familiarity with this group can easily carry on such work which, in addition to its great biological interest, is absolutely essential before satisfactory measures can be taken for the control of ticks.

TECHNIQUE AND METHODS.

For the study of the structure of the capitulum, the foot, the spiracle, etc., microscopical preparations were made. The drawings of these parts published in this paper are camera-lucida sketches from preparations mounted in Canada balsam and have been corrected by the examination of the specimens under a Greenough binocular dissecting microscope.

A useful method of making mounted preparations of the chitinous parts was suggested to me by Mr. M. A. Hussain. The parts intended for permanent preparations were left in 10 per cent. caustic potash solution for about three hours and were then transferred into glacial acetic acid. The specimens can be safely left in acetic acid for any length of time; ordinarily, however, they were kept for a few hours and then transferred to absolute alcohol. They were stained with picric acid in xylol and mounted in Canada balsam after clearing in clove oil.

TERMINOLOGY.

In the description of the species I have followed the terminology used by Nuttall and Warburton (1911) and Robinson (1926) in their Monographs. In recent years certain new terms have been introduced by Schulze (1919, pp. 190, 191) and Jacob (1924a). Most of these are worth adopting and in some cases I have used their nearest English equivalents in my descriptions, while in others I have retained them in their original form.

The *cervical field* ("Zervikalfeld or Cervikalfeld" of Schulze and Chodziesner) is the depressed area between the cervical groove and the lateral groove of the same side in the female.

The scutum is said to be *constricted* ("eingezogen" according to Schulze) if it is somewhat narrow at the level of the spiracles.

The *caudal field* ("Kaudalfeld or Caudalfeld" of Schulze and Chodziesner) is a triangular depressed area, which may be coarsely punctate, in the posterior half of the male scutum. This area is well marked in certain species of the genus *Hyalomma*.

The term *parma* is used by Schulze for the dorsal surface of the median festoon when it is whitish in colour and is sharply marked off from the rest of the dark scutum, but I have extended its use to denote the dorsal surface of the median festoon when this is differentiated from the rest of the scutum by grooves even when it is of the same colour.

The spiracle is said to be *comma-shaped* ("Kommaförmig") if the rounded head portion passes gradually into the dorsally directed broad tail portion so as to look like a comma, and *retort-shaped* ("Retortenförmig") if the rounded head portion is sharply marked off from the long narrow tail portion, and its appearance is like that of a retort.

The *sub anal shields* (" Subanalplatten " of Schulze) are the chitinous shields behind the adanal shields present in the subgenus *Hyalomma* and the genus *Nosomma*.

A *lateral salience* or *projection* (" Umschlag " of Schulze) is sometimes present either on palpal article II, or on article III, or even on both of them on the external margin near the base.

The *palpal angle* [" Palpenwinkel " of Jacob (1924a, p. 344)] is the gap between the palp and the hypostome. It is well marked in members of the genus *Ixodes* and is clearly seen when the ticks are viewed from the dorsal aspect.

The *bristle formula* [" Borstenformel " of Jacob (1924a, p. 342)] is used to represent the number of hairs present on the infra-internal margin of palpal articles I to III.

In order to avoid confusion I give below certain terms which have been introduced by Schulze together with the earlier terminology of Nuttall and his co-workers.

Adanalplatten=accessory shields.
Analplatten=adanal shields.
Peltae=scutes.

Senevet (1922, pp. 396, 397) has also introduced a few terms that appear to me to be unnecessary and he has thus added to the confusion in the terminology. His " *champ cervical* " corresponds to the *median field* of Nuttall and his co-workers, and his " *ecusson post-anal* " to the sub-anal shield.

I have found it necessary to introduce the following new terms :—

The *post-genital plate* is a crescent-shaped chitinous plate strengthening the soft chitin immediately behind the male genital aperture in most of the genera.

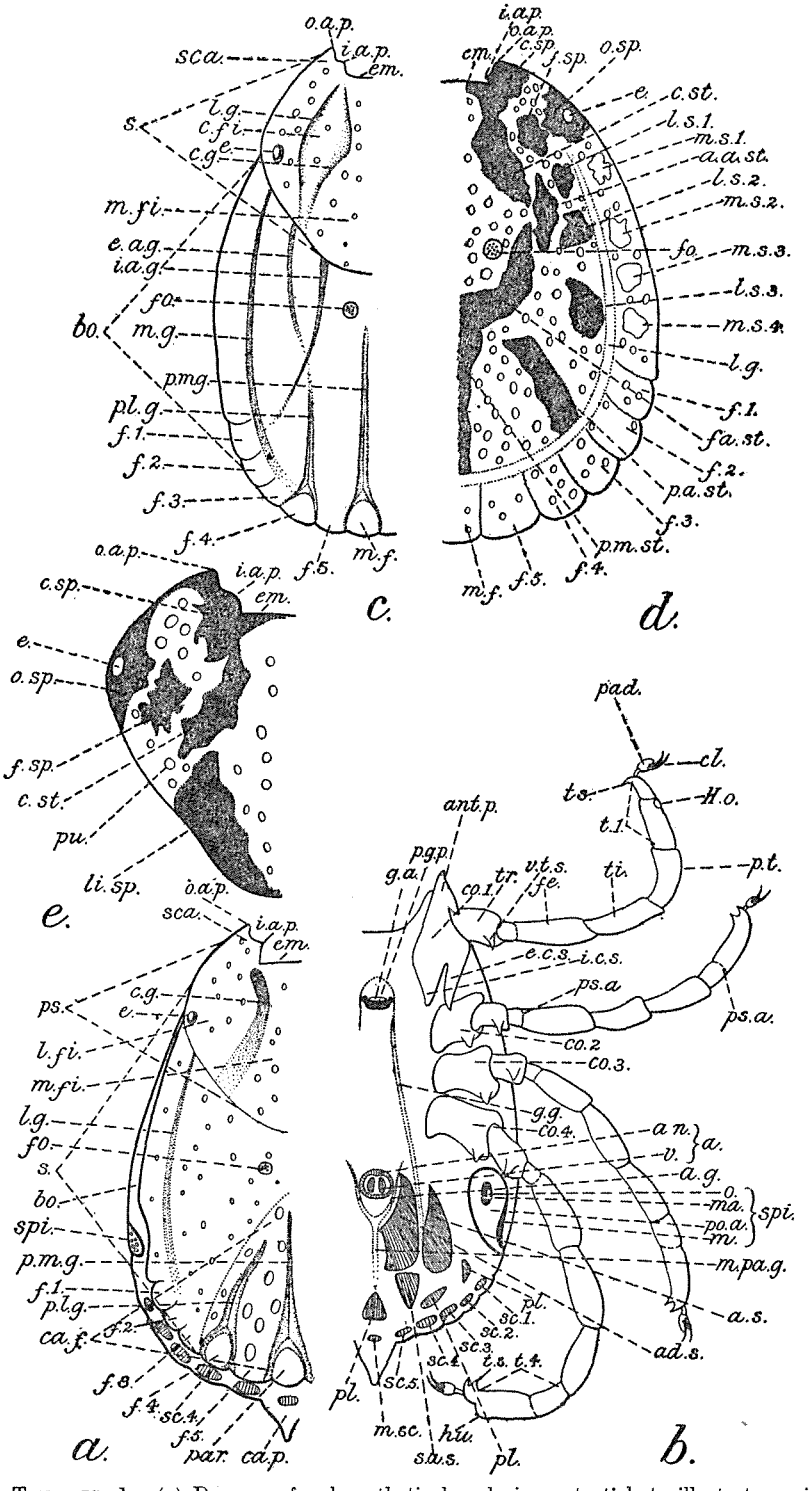
The *supra-internal margin* is the internal margin of the dorsal surface of the palp. The *infra-internal margin* is the internal margin of its ventral surface.

In the description of the ornate species of the genera *Aponomma* and *Dermacentor* I have adopted the terminology used by Dönitz and Robinson in their description of the genus *Amblyomma*. For the colours of the various species I have followed the standards laid down in Ridgway's famous work[1].

In the measurements of various parts I have, for the most part, followed the method adopted by Nuttall and his co-workers but have departed from it in taking the measurement of the length of the capitulum from the middle of the dorsal ridge to the middle of a line joining the tips of the palps. In my opinion the measurement from the dorsal ridge to the tip of the hypostome is not reliable as this organ is more liable to injury than any other part of the capitulum and is sometimes shortened by the folding of its proximal portion.

In order to make this work as useful as possible to Veterinary Surgeons in this country I have given below a few diagrammatic sketches of a hypothetic tick in order to explain the terms used for the various parts of the tick morphology. For the terminology used for the ventral plates of a male tick of the genus *Ixodes* see text-fig. 3.

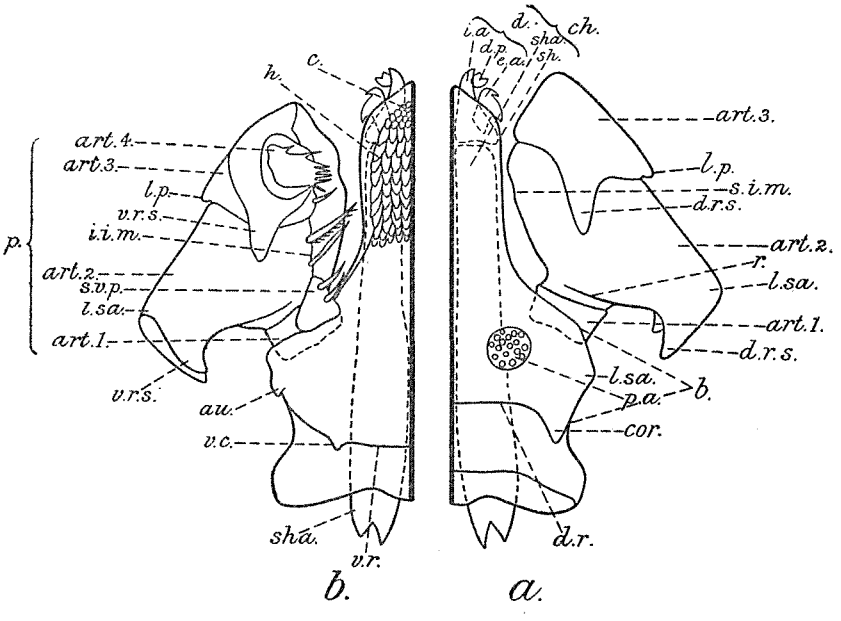
[1] Ridgway, *Color Standards and Color Nomenclature.* (Washington, 1912).



TEXT-FIG. 1.—(*a*) Dorsum of a hypothetical male inornate tick to illustrate various external features; (*b*) venter of a hypothetical male tick to illustrate various external

features; (*c*) dorsum of a hypothetical female inornate tick to illustrate various external features; (*d*) scutum of a hypothetical male ornate tick to illustrate various stripes and spots; (*e*) scutum of a hypothetical female ornate tick to illustrate various stripes and spots.

a. anus; *a. a. st.* antero-accessory stripe; *ad. s.* adanal shield; *a. g.* anal groove; *an.* annulus; *ant. p.* anterior process of coxa I; *a. s.* accessory shield; *bo.* body; *c. fi.* cervical field; *ca. f.* caudal field; *ca. p.* caudal process; *c. g.* cervical groove; *cl.* claw; *co. 1-4.* coxae I-IV; *c. sp.* cervical spot; *c. st.* cervical stripe; *e.* eye; *e. a. g.* external anterior accessory groove; *e. c. s.* external coxal spur; *em.* emargination of the scutum; *f. 1-5.* festoons I-V; *fe.* femur; *fo.* fovea; *f. sp.* frontal spot; *fa. st.* falciform stripe; *g. a.* genital aperture; *g. g.* genital groove; *H. o.* Haller's organ; *hu.* hump; *i. a. g.* internal anterior accessory groove; *i. a. p.* internal articulating process of the scapula; *i. c. s.* internal coxal spur; *l. g.* lateral groove; *l. fi.* lateral field; *li. sp.* limiting spot; *l. s. 1-3.* lateral spots I-III; *m.* margin of the spiracle; *ma.* macula; *m. g.* marginal groove; *m. f.* median festoon; *m. fi.* median field; *m. pa. g.* median post-anal groove; *m. s. 1-4.* marginal spots I-IV; *m. sc.* median scute; *o.* ostium; *o. a. p.* outer articulating process of the scapula; *o. sp.* ocular spot; *pad.* pad or pulvillum; *par.* parma; *p. a. st.* postero-accessory stripe; *p. g. p.* post-genital plate; *pl.* plaque; *p. l. g.* postero-lateral groove; *p. m. g.* postero-median groove; *p. m. st.* postero-median stripe; *po. a.* porous area of the spiracle; *ps.* pseudo-scutum; *ps. a.* pseudo-articulation; *p. t.* protarsus; *pu.* punctation; *s.* scutum; *s. a. s.* sub-anal shield; *sc. 1-5.* scutes I-V; *sca.* scapula; *spi.* spiracle; *t. 1-4.* tarsi I-IV; *ti.* tibia; *tr.* trochanter; *t. s.* tarsal spur; *v.* valve; *v. t. s.* ventral trochantal spur.



TEXT-FIG. 2.—Capitulum of a hypothetical tick. (*a*) Dorsal view; (*b*) ventral view. *art. 1-4.* articles I-IV of the palp; *au.* auricula; *b.* base (basis capituli); *c.* corona; *ch.* chelicera; *cor.* cornua; *d.* digit of the chelicera; *d. p.* dorsal process; *d. r.* dorsal ridge; *d. r. s.* dorsal retroverted spur; *e. a.* external article of the cheliceral digit; *h.* hypostome; *i. a.* internal article of the cheliceral digit; *i. i. m.* infra-internal margin; *l. p.* lateral projection; *l. sa.* lateral salience; *p.* palp; *p. a.* porose area; *r.* ridge; *sh.* sheath of the chelicera; *sha.* shaft; *s. i. m.* supra-internal margin of the palp; *s. v. p.* setiferous ventral plate under palpal article I; *v. c.* ventral cornu; *v. r.* ventral ridge; *v r. s.* ventral retroverted spur.

THE CAPITULUM AND ITS MODIFICATIONS IN DIFFERENT GENERA FOR ADEQUATE FIXATION IN ACCORDANCE WITH THEIR PARASITIC HABIT.

Ticks, being ecto-parasites, exhibit certain structural modifications for attachment to their hosts. Such modifications are found chiefly in the capitulum, the feet and the tarsi; of these, the capitulum becomes partly embedded in the skin of the host, while the others only assist the tick in taking a firm hold on the body of the host. The capitulum lies in a straight line with the main axis of the body, and of its constituent parts only the chelicerae and the hypostome, which together form the proboscis or the haustellum, are inserted into the skin. In order to force the proboscis into the skin it is necessary that the tick should be able to take a firm hold of the host, and this is brought about by the powerful claws of the feet and by the tarsal spurs, which also vary according to the needs of the different species of ticks.

After the feet have taken a firm hold of the host, the tick proceeds to push its proboscis into the skin. Generally the cheliceral digits alone make the incision through which the proboscis is pushed in. The scapulae and, in some cases, the anterior projections of the first pair of coxae also play an important part in the introduction of the proboscis into the skin of the host, and in accordance with this function their articulations with the capitulum vary in different genera. In some cases they also assist in keeping the palps close to each other so as to maintain a firm hold of the host. The palps never pierce the skin, but by their approximation indirectly assist the tick in taking a firm hold of the host and in consequence they also have undergone various modifications. Their movements are of course chiefly controlled by the internal muscles, but the external processes and saliences on them limit their movements to a considerable extent. The hairs on palpal articles I-III seem to have the purely mechanical function of rendering their surfaces rough and they thus assist the palps in their function by a purely frictional device. The palpal hairs show considerable variation in form, size and number and this variation is in my opinion correlated with the part which the palps are required to play in securing a firm hold of the host. In this connection I attach special importance to the hairs that are found on the infra-internal margin of palpal articles I-III, for which Jacob[1] has devised his bristle formula. In some species they play an important part in assisting the palps to take a firm hold of the host, while in others they do not appear to act in this manner: consequently they are much more subject to variation than hairs on other parts of the palps. A well developed setiferous ventral plate on palpal article I is found in all Indian genera excepting *Ixodes* Latreille, *Haemaphysalis* Koch and *Boophilus* Curtice. Bonnet[2] considers that the hairs on this plate are sensory in function but the only conclusion that can, I think, be drawn from the variation in their

[1] Jacob (1924a, p. 341), as the following statement clearly shows, believes these hairs to have some unknown mechanical function. "Aus diesem Grunde erscheint mir eine uns noch unbekannte mechanische Funktion dieser Borsten nicht ausgeschlossen. Für diese Annahme spricht vielleicht auch, dass sie sehr oft in verschiedener Höhe abgebrochen sind."

[2] Bonnet, *Ann. Univ. Lyon.*, (Nouv. Sér. I. Sciences, Médicine) fasc. XX, p. 42 (1907).

number, size and form in the different species of the same genus is that their function is purely mechanical.

The hypostome is as a rule broad anteriorly and thus is not adapted for making the preliminary incision into the skin. The anterior portion is provided with a minutely denticulated corona, which is especially adapted for penetration through the minute incision made by the chelicerae, which usually reach beyond the tip of the hypostome. The corona is found in all species of genera other than *Ixodes*. In this genus it is present in a few species in which the chelicerae reach beyond the tip of the hypostome. The disparity in the size and form of the cheliceral digits in the male and female is to be explained by the difference in the parasitic habits of the two sexes. It is well marked in species in which the males are not parasitic, as in *Ixodes vespertilionis* Koch.

The base of the capitulum differs in form in various genera of the family Ixodidae. The cornua, together with the dorsal ridge, prevent the up-turning of the capitulum and in different species exhibit variations in size correlated with the requirements of the species. In species in which the capitulum is short the cornua are better developed and prevent the up-turning of the capitulum, but in the species in which the capitulum is long, a slight up-turning of the capitulum does not prevent the penetration of the proboscis into the skin of the host, and hence the cornua are either totally absent or but poorly developed.

The modifications met with in the various structures constituting the capitulum of the different genera are correlated with the habits of the ticks. The limiting of the range of the lateral movement of the palps is necessary in genera in which the hypostome alone is not capable of taking a secure hold of the host. This is brought about in different ways which are dealt with in the account of the various genera, but the most effective contrivance in this connection is formed by the fusion of palpal articles I and II, since palpal article I is mostly embedded in the base of the capitulum and consequently is capable of only a very limited lateral movement. Such a condition is met with in the adults of the genus *Boophilus* and is also to be seen in the earlier stages of certain other genera. The palps in the nymphs and larvae of the genera in which the capitulum is long show no trace of fusion between palpal articles I and II. This is because the hypostome in these forms is long, spatulate and provided with comparatively strong teeth; it is quite sufficient for fixation, and no additional support is necessary. In genera with a short capitulum, however, palpal articles I and II are totally fused in the nymphs, though articles II and III are either only partially fused or are not fused at all; in the larvae all three articles are fused. In these cases the hypostome alone is not sufficient for fixation and is assisted by the palps, which, on account of the fusion of their articles, are capable of only a limited degree of lateral movement.

In the genus *Ixodes* the capitulum exhibits a considerable range of variation in size, form and structure. The base is variable in shape and the scapulae articulate generally behind its postero-lateral angles. The palps are generally long with a constriction near the proximal end of article II and usually have a few very minute and simple hairs. Article

I, though prominent, is without any setiferous ventral plate and is practically devoid of hairs on its infra-internal margin. The palps have no lateral salience and can freely move laterally up to a position in which they lie in a straight line with the anterior margin of the base. They thus play no part in maintaining a hold of the host, but on the other hand allow the proboscis, which is comparatively long, to be inserted to its full length into the skin. The ventral surfaces of the palps are much less broad than their dorsal surfaces. This and the proximal constriction of the palps are, in my opinion, to lessen friction and to prevent the palps becoming entangled in the hairy or the feathery covering of the hosts, which would be detrimental to the complete insertion of the proboscis into the skin. The only organ of fixation in this genus is the hypostome, though the large number of teeth of the cheliceral digits also helps it in this function. The marked sexual dimorphism of the hypostome, as pointed out by Nuttall and Warburton (1911, pp. 135, 342, 343) and by Neumann[1], is correlated with the different modes of habit in the two sexes: the nymphs and the larvae, which lead a long parasitic life like the female, have a well developed hypostome and the other structures of the capitulum are as in the female. The hypostome shows a considerable range of variation in accordance with the blood sucking habit of the different members of the genus. According to Nuttall and Warburton the hypostome is poorly developed, practically unarmed and is broad anteriorly in the males of *Ixodes hexagonus* Leach, *I. canisuga* Johnston, *I. putus* (Pickard-Cambridge) and *I. vespertilionis* Koch, which are not parasitic at any period of their life. It is well developed, armed and almost pointed anteriorly in the females, nymphs and larvae of the above mentioned species, all of which lead a parasitic life for a long time. It is comparatively short and is less armed in the male than in the female of species like *I. ricinus* (Linn.), in which the male is only parasitic during a short period for copulation with the parasitic female. The teeth on the hypostome in this genus differ greatly in size, those on the external rows are directed outwards and backwards and are longer and stronger than those in the internal rows. There is generally a ridge between the rows of teeth on the two halves of the hypostome. This type of hypostome is better suited for maintaining a strong hold of the host than any of the types found in other genera of the family Ixodidae, and it is on this account that most members of this genus are much more difficult to dislodge.

The chelicerae in some species of the genus *Ixodes* do not reach beyond the tip of the hypostome and this is especially the case in the females of *I. acuminatus* Neumann, *I. brunneus* Koch and *I. vespertilionis* Koch. In these species the hypostome is lanceolate and very much pointed anteriorly and the preliminary rupturing of the skin is, in my opinion, carried out both by the hypostome and the cheliceral digits. The latter, which are very dentate, probably also play some part in fixing the proboscis to the skin of the host. In the males of this genus the chelicerae usually either reach to or extend beyond the tip of the hypostome, which is broad anteriorly. In these cases it is the cheliceral

[1] Neumann, *Das Tierreich* XXVI, p. 5 (1911).

digits alone that first come in contact with the skin of the host and make the preliminary puncture in it.

In the genus *Haemaphysalis* the base is rectangular and the scapula has two articulating processes, of which the inner one is short and articulates below the cornua, while the outer is long and runs parallel to the lateral side of the base. The anterior projection of coxa I and the outer articulating process of the scapula articulate with the lateral salience of palpal article II and thus limit its lateral movements. The capitulum in this genus is short ; the palps assist in taking a firm hold of the host and consequently they have undergone various kinds of modifications. In *H. inermis* Birula and *H. warburtoni* Nuttall the palps are without lateral saliences and the outer articulating process of the scapula articulates below the slightly developed postero-lateral angle of the base. The palps are thus capable of free lateral movements and possess only a few simple hairs : they play no part in maintaining a hold of the host. The hypostome is strongly spatulate and only a little more than the anterior half forms a somewhat effective fixing organ, as in the ticks with a long rostrum. Both these species are, therefore, poorly adapted for taking a strong hold of the host and this is correlated with the peculiar blood-sucking habit of the species. Brumpt[1], who has studied the life-history of *H. inermis* has shown that this tick is a somewhat rapid feeder and prefers to attack parts having a thin and soft skin and these two facts are sufficient to explain the poor development of the organs of fixation. In the remaining species of the genus *Haemaphysalis* the hypostome is short and less spatulate, with the lateral sides almost parallel, and throughout nearly the whole of its length is provided with many rows of small teeth of almost uniform size. Consequently it is not very efficient as a fixing organ and these ticks have to depend upon some other support which in this instance is afforded by feathery hairs, spurs, ridges or lateral saliences on the palps. The palps of these species possess on article II a lateral salience which varies in size in different species. In those species in which the lateral salience is comparatively little developed either (1) the hairs on the infra-internal margin of article II are numerous, long and strongly feathery, thus assisting the palps in taking a firm hold by means of a frictional device, as in *H. cinctabarina* var. *punctata* (Canestrini and Fanzago) and *H. sewelli* sp. nov., (2) the ventral spurs on the palps are strongly developed as in *H. montgomeryi* Nuttall, (3) the hypostome has many rows of teeth as in *H. sundrai* sp. nov. and comparatively is a more efficient fixing organ than in most of the other species of the genus *Haemaphysalis*, or (4) there is a fusion between palpal articles I and II as in *H. birmaniae* Supino and *H. flava* Neumann. In species in which the lateral salience on palpal article II is strong, as in *H. leachi* (Audouin), *H. spinigera* Neumann and *H. calcarata* Neumann, it is scooped out posteriorly, mainly for the articulation of the anterior projection of coxa I and to some extent for the outer articulating process of the scapula. The lateral salience and its retroverted processes limit the lateral movement of the palps to a considerable extent. The hairs on the palps are few and simple. When the

[1] *Vide* Nuttall and Warburton, *Ticks* part 3, pp. 545-547 (Cambridge, 1915).

hypostome is inserted into the skin the approximation of the palps helps the tick to take a firm hold of the host.

In *Dermacentor* Koch the base is rectangular and each scapula has two articulating processes, as in the genus *Haemaphysalis*. The palps are short but very broad; the second article, though it has no well developed lateral salience, has a strong raised dorsal ridge separating its distal broad portion from the proximal narrow portion. When the palps diverge outwards this ridge comes to lie against the anterior side of the base. The dorsal ridge on article II, the broad shape of the palp and a slight fusion between articles I and II partially limit the lateral movement of the palps and the outer articulating process of the scapula does not allow the palps to diverge beyond a definite limit. The hairs on the infra-internal margin of the palps are simple and those on the ventral plate of article I are longer than the others. The hypostome is broad with parallel sides and is armed down to the base with strong and sub-equal teeth. Practically the whole of it is inserted into the skin of the host and it forms an efficient organ of fixation. In such a case only the hairs on the proximal ventral portion of the palp can serve any useful purpose. The palps in the adults of this genus are generally without spurs and have only a few simple hairs and consequently they do not play a very important part in taking hold of their host. In the few nymphs of this genus which have been so far described the hypostome is comparatively much longer than that of the adult. The hypostome is strongly spatulate. The palps are long, narrow, without any lateral salience or transverse ridge and palpal article I is not fused with article II. In these nymphs the only organ of fixation is the hypostome and the palps do not play any part in maintaining a hold of the host.

In *Rhipicephalus* Koch the base is hexagonal with salient lateral angles. The outer articulating process of the scapula and the anterior projection of coxa I in some species articulate with a depression on the posterior surface of the lateral salience of the base. The palps are short and article I shows a tendency towards fusion with article II, especially on the ventral side where the two are almost totally fused; dorsally, article I is almost entirely concealed within the base. This partial basal fusion of the palp limits its lateral movement to a considerable extent. Article III has a ventral retroverted spur which is rather weak and is probably of but little use. The ventral plate on article I is large and provided with strong feathery hairs, usually seven in number. The infra-internal margin of article II possesses a similar number of strong feathery hairs. The lateral margins of the hypostome are parallel and the organ is provided with strong, equally-developed teeth down to the base. Though the hypostome itself is very efficient for the purpose of fixation, it is also supported by the palps, which on account of a partial basal fusion and the presence of strong feathery hairs serve as an additional organ for taking a firm hold of the host.

In the genus *Boophilus* Curtice the base is broad and hexagonal with slight lateral saliences. The inner articulating process of the scapula articulates under the cornua and the outer articulating process, along with a very strong anterior projection of coxa I, articulates behind the

lateral salience of the base. The palps are extremely short and articles I and II are entirely fused. The hairs on the palps are very few and simple. The basal fusion of the palps and the slight posteriorly-placed lateral saliences together check the lateral movements of the palps. The ventral spurs of the palps are rudimentary and consequently are of little importance. The hypostome is short with parallel lateral margins and is armed with equal teeth almost down to the base. The capitulum in this genus is very short and is less efficient than in all the other genera of the family Ixodidae. Ticks of this genus[1] pass the whole of their time from the larval stage up to the replete adult on the host, but the real parasitic period is very short and there is a renewal of attachment after every metamorphosis. These facts in the life-history are correlated with the poorer development of the organs of fixation, and these ticks are comparatively easy to dislodge.

In the genus *Nosomma* Schulze the capitulum is like that of the genus *Dermacentor*, but the palpal articles I and II in the former genus are provided with more numerous and stronger hairs on their infra-internal margin, and the fusion between articles I and II is a little more complete than in the latter. The palps are very short and their lateral movement is checked by the outer articulating limbs of the scapulae. The hypostome is slightly spatulate and has equal teeth anteriorly over rather more than half its length. The fixation to the host is carried out by the hypostome which is assisted by the palps in taking a firm hold of the host. The capitulum of this genus is, therefore, better adapted for taking a firm hold than that of the genus *Dermacentor*.

In *Hyalomma* Koch the capitulum is long. It shows slight differences in the two subgenera *Hyalomma* and *Hyalommina* Schulze. In the subgenus *Hyalommina* the base is broad and hexagonal in both the sexes and the scapula articulates by two processes below the cornua and behind the lateral salience. The palps are long, with all the articles distinctly separate. Owing to the absence of lateral saliences and spurs on the palps they are capable of free lateral movement. The hypostome is spatulate and its anterior half is provided with strong teeth, which increase in size from the innermost to the outermost rows. Its posterior portion bears an equal number of rows of scale-like teeth which appear to be in process of degeneration. It is only the anterior larger half of the hypostome which is the chief organ of fixation and the posterior teeth are becoming rudimentary from want of use. The hairs on the ventral plate on article I are long and simple and lie close to the skin of the host when the anterior half of the hypostome is inserted into it. These probably enable the proximal portion of the palp to play some part in maintaining a hold of the host by a frictional device. In the subgenus *Hyalomma* Koch the base in the males is rectangular, and only the inner articulating process of the scapula articulates with it below the cornu, while the outer process runs parallel to its lateral side. In the

[1] According to Hooker, Bishopp and Wood [*U. S. Dept. Agric. Bureau Entom. Bull.* No. 106 pp. 116, and 120 (Washington, 1912)] the average period of attachment to the host from the larva to the replete adult is 32 days in the case of *B. annulatus* (Say) and 23 days in the case of *B. australis* (Fuller). This period in each case includes the time taken by the two metamorphoses.

females the base is sub-triangular and the outer articulating process of the scapula is large and articulates behind the lateral salience of the base. The scapulae of the female are, therefore, better adapted for the discharge of their function than those of the male. This is quite in accord with the difference in the blood-sucking habits of the two sexes.

In *Amblyomma* Koch the capitulum is longer than in any other genus. The scapulae articulate with the base below the obsolete cornua. The palps are long and narrow, without spurs, do not show any basal fusion and article III is bent slightly inwards. They possess free lateral movements and are of no use in the attachment of the ticks to the host. The ventral plate on article I usually possesses two simple hairs and is much below the level of the anterior functional portion of the hypostome; the hairs are of no use for fixation. The hypostome is long and strongly spatulate, its anterior third is armed with strong teeth of unequal size and there are numerous rows of scale-like non-functional teeth on the posterior portion. It is the anterior portion of the hypostome which is responsible for the fixation of the tick to the host and on account of the regular increase in the size of the teeth from the internal to the external rows, it is a very efficient organ.

In *Aponomma* Neumann the modifications of the capitulum are similar to those found in the genus *Amblyomma*, but the hypostome is intermediate in type between those of *Amblyomma* and *Hyalomma*. The capitulum is comparatively shorter than that of *Amblyomma*, since the scales of the host, which is always a reptile, give some support to the capitulum.

SUMMARY OF PREVIOUS WORK ON THE INDIAN IXODIDAE, WITH A SYNOPTIC KEY TO THE INDIAN GENERA.

The history of our knowledge of the Indian Ixodid ticks dates from the time of Linnaeus who described *Acarus elephantinus* * in 1758 and *Acarus indus* * in 1767 from India. In 1870 Rudow described *Amblyomma bengalense* * off *Python* sp. from Bengal. Murray (1877), in his 'Economic Entomology' (Aptera), gave a brief description of *Ixodes brevipes* * from Ceylon and Karsch (1879) described *Amblyomma integrum* and *Amblyomma distinctum* [1] from the same island.

In 1897 Supino [2] in three papers described twenty new species, belonging to five genera, from material collected by Fea in Burma. His descriptions and diagrams of these species, as Neumann has pointed out, are so incomplete and poor, that it is impossible to come to any conclusion about their validity. Supino mainly based his species on differences in the form and structure of tarsus I and the hypostome; but both these characters, as is well known, are unreliable for the purpose

* All these are doubtful species according to Neumann (*vide Das Tierreich*, XXVI, pp. 126, 127, 89 and 130, respectively, (1911)], but in my opinion *I. brevipes* Murray is probably *Boophilus australis* (Fuller) though the original description is too meagre to enable the point to be decided with certainty.

[1] *A. distinctum* Karsch is a synonym of *A. hebraeum* Koch and its record from Ceylon is accidental [*vide* Robinson, *Ticks*, II (part 4), pp. 104-107. (Cambridge, 1926)].

[2] Supino, *Atti. Soc. Veneto-Trent. Sci. Nat.* (2) III, pp. 230-238 (1897); *id. ibid.*, pp. 241-252, pls. xii, xiii, figs 1-23 (1897); *Id., Nuovi Ixodes della Birmania.* Padova: Stab. P. Prosperini., pl. xii (1897).

of differentiation of species. Neumann,[1] who had an opportunity of examining the types of eleven of Supino's species, found *Ixodes granulatus* Supino, *Dermacentor auratus* Supino, *Haemaphysalis birmaniae* Supino and *H. hystricis* Supino, as good species and for the remaining seven species he gave the following identifications :—

1. *Ixodes testudinis* Supino=*Amblyomma testudinis* (Supino).[2]
2. *Ixodes varanensis* Supino=*Aponomma gervaisi* (Lucas).
3. *Rhipicephalus javanensis* Supino=*Amblyomma badium* Neum.[3]
4. *Rhipicephalus haemaphysaloides ruber* Supino=*Rhipicephalus haemaphysaloides* Supino.
5. *Dermacentor indicus* Supino=*Amblyomma badium* Neum.
6. *Opisthodon canestrinii* Supino=*Haemaphysalis leachi* (Audouin).
7. *Opisthodon gestroi* Supino=*Haemaphysalis leachi* (Audouin).

The types of the remaining nine species appear to have been lost when the collection passed through various hands after Canestrini's death and *Ixodes birmanensis*, *Ixodes bengalensis*, *Ixodes globulus*, *Rhipicephalus flavus*, *Rhipicephalus bhamensis*, *Rhipicephalus haemaphysaloides niger*, *Dermacentor feae*, *Dermacentor longipes* and *Opisthodon asiaticus* now exist only in name.

Neumann (1897, 1899a, 1901, 1906 and 1910) in a series of papers described *Haemaphysalis flava*, *Haemaphysalis spinigera*, *Haemaphysalis bispinosa*, *Ixodes laevis* [=*I. acutitarsus* (Karsch)], *Ixodes holocyclus*, *Dermacentor compactus* [=*D. auratus* Supino], *Amblyomma latiscutatum*,[4] *Amblyomma prolongatum* (=*A. integrum* Karsch), *Amblyomma zeylanicum* (=*A. clypeolatum* Neumann) and *Haemaphysalis parva*, and in 1897 recorded *Rhipicephalus sanguineus* (Latreille) and in 1899 *Aponomma gervaisi* (Lucas) and *Hyalomma aegyptium* (Linn.) for the first time from India. In 1902 he also recorded *Rhipicephalus annulatus*[5] (Say) from Ceylon. In 1911 he published his monograph on the Ixodidae in the '*Das Tierreich*' series. In this he added *Amblyomma testudinarium* Koch to the Ceylonese list and *Amblyomma clypeolatum* Neumann to the Indian list.

In 1901 Stiles and Hassall recorded *B. australis* for the first time from India and Lavarra (1904) described *Haemaphysalis aculeata* from Ceylon. Christophers (1907) records *Haemaphysalis flava* Neumann, *Rhipicephalus bursa* (Can. and Fanz.), *Rhipicephalus simus* Koch and *Rhipicephalus annulatus* (Say) from Southern India but his identifications of these species are open to question.

Warburton[6] published a short account of certain Indian species and in 1909 with Nuttall he described *H. bispinosa* var. *intermedia*. In the following year he published a report on the ticks belonging to the Indian Museum and those of the Dobell-Willey collection. Besides

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[1] Neumann, *Arch. Parasitol.* VI, pp. 122-128 (1902).

[2] *A. testudinis* Supino was changed into *A. supinoi* in 1905 by Neumann as the former specific name was pre-occupied. [*vide* Neumann, *Arch. Parasitol.* IX, p. 234 (1905)].

[3] *A. badium* Neumann is a synonym of *A. sublaeve* Neumann.

[4] According to Robinson (1926, p. 283) *A. latiscutatum* is a doubtful species.

[5] Neumann here probably means by *R. annulatus* (Say) *B. australis* (Fuller) which is the commonest cattle tick in Ceylon.

[6] Warburton, *Bull. Imp. Dept. Agric. India*, No. 6, pp. 1-13 (1907).

the species previously known from India, *Ixodes gigas* [=*I. acutitarsus* (Karsch)], *Rhipihcepalus breviceps* [=*R. sanguineus* (Latreille)], *Haemaphysalis longipalpis* (=*H. aculeata* Lavarra), *Haemaphysalis cuspidata*, *Haemaphysalis leachi* var. *indica*, *Amblyomma annandalei* (= *A. supinoi* Neumann) and *Aponomma gervaisi* var. *lucasi* were described and *Aponomma laeve* Neumann, *Haemaphysalis leachi* var. *australis* Neumann, *Hyalomma syriacum* Koch, *Amblyomma decoratum* Koch (=*Amblyomma helvolum* Koch) and *Amblyomma testudinarium* were recorded as occurring in this country. He subsequently (1913) described *Haemaphysalis aborensis* (=*H. birmaniae* Supino) from the Abor country, *Haemaphysalis howletti* from Rawalpindi, *Haemaphysalis kinneari* from Kanara, *Haemaphysalis cornigera* var. *anomala* from Kodarma and *Haemaphysalis inermis* var. *aponommoides* from Calcutta. In 1925 he published a short report on the Ixodidae of the Colombo Museum and *Aponomma trimaculatum* (Lucas) was added to the list of the Ceylonese ticks.

In 1912 Nuttall described *Haemaphysalis montgomeryi* from Almora and Naini-Tal Districts and in 1913 he described *Ixodes kempi* (=*I. granulatus* Supino) from the Abor country. *I. ricinus* (Linn.) was recorded by him for the first time from India (Kashmir) in 1916.

In 1908 Nuttall and Warburton described *Amblyomma atrogenatum* (=*A. clypeolatum* Neumann) off *Testudo elegans* Schoep. from India and *Hyalomma monstrosum* (=*Nosomma monstrosum*) from the Chin Hills. In 1911 these two workers along with Robinson and Cooper published a comprehensive work entitled "*Ticks: A Monograph of Ixodoidea*," part 2, dealing with the genus *Ixodes*, and in 1915 they published a third part dealing with the genus *Haemaphysalis*, in which *H. turturis* was described and *H. wellingtoni* and *H. campanulata* were recorded for the first time from India. In 1926 Robinson published *Ticks: A Monograph of Ixodoidea*, II (Part 4), dealing with the genus *Amblyomma* in which six previously recorded species of the genus were redescribed.

Leaving aside the doubtful species, the family Ixodidae is represented in India, Burma, Ceylon, the Andamans and Nicobars by nine genera and forty-five species, four sub-species and six varieties; among these I have described five species, two subspecies and one variety as new and one species and two subspecies are recorded for the first time from India.

The following is a key to the Indian genera of the family Ixodidae:—

I. Anal groove embracing the annus in front; festoons absent; venter in the male presents seven non-salient chitinous plates; tarsi without spurs .. *Ixodes.*

II. Anal groove either embracing the anus behind or obsolete; festoons generally present; in the male only four or six ventral shields when present.

A. Eyes absent.

I. Capitulum short, generally with lateral salience on palpal article II; trochanter I with a blade-like dorsal retroverted spur; coxa I never bifid .. .. *Haemaphysalis.*

II. Captitulum long, without lateral salience on palpal article II; trochanter I without any dorsal retroverted spur; coxa I generally bifid .. .. .. *Aponomma.*

B. Eyes present.
I. Capitulum short with short broad palps.
A. Basis-capituli rectangular dorsally and without lateral saliences; scutum usually ornate; six ventral shields in male when present.
1. Male with six ventral shields and with coxae sub-equal .. *Nosomma.*
2. Male without ventral shields and with coxa IV much larger than others .. *Dermacentor.*
B. Basis capituli hexagonal dorsally with lateral saliences; scutum usually inornate; only four ventral shields in male.
1. Spiracle oval; festoons and anal groove obsolete; palpal article I without setiferous ventral plate .. .. *Boophilus.*
2. Spiracle sub-triangular or comma-shaped; festoons and anal groove well marked; palpal article I with setiferous ventral plate .. *Rhipicephalus.*
II. Capitulum long with long narrow palps.
A. Male with ventral shields; scutum usually inornate; eyes spherical and orbital : .. .. *Hyalomma.*
B. Male wthout ventral shields; scutum usually ornate; eyes generally flat and non-orbital .. .. *Amblyomma.*

Genus **Ixodes** Latreille.

1911. *Ixodes*, Nuttall and Warburton: in Nuttall, Warburton, Cooper and Robinson, *Ticks*: *A Monograph of the Ixodoidea* part 2, pp. 116, 133-135 (Cambridge).
1911. *Ixodes* (*Ixodes, Ceratixodes* and *Eschatocephalus*), Neumann, *Das Tierreich* XXVI, pp. 8, 29, 30.
1913. *Ixodes* (*Ixodes, Ceratixodes* and *Eschatocephalus*), Patton and Cragg, *A Textbook of Medical Entomology*, pp. 590, 595, 596 (Madras).
1916. *Ixodes*, Nuttall, *Bull. Entom. Research* VI, p. 318.

In this country ticks of this genus are known only from hilly regions and are not very common. Four species of this genus have so far been recorded from India. In the case of *Ixodes holocyclus* Neum.[1] only the nymphs have so far been recorded from India.

The following is a key to the Indian species of this genus :—

Males.

I. Dorsum with two lateral folds; anal grooves convergent posteriorly; coxa I without internal spur; pre-genital plate broader than long .. .. *holocyclus.*
II. Dorsum with a single lateral fold; anal grooves divergent posteriorly; coxa I with internal spur; pre-genital plate longer than broad.
A. Coxa I with one prominent internal spur only; lateral grooves absent; species of a small size *ricinus.*
B. Coxa I with two very long spurs situated close together; lateral grooves present and continuous; species of a large size .. .. *acutitarsus.*

[1] *Vide* Nuttall and Warbuton, *Ticks* part 2, pp. 235-238, text-figs. 230-232 (Cambridge, 1911).

FEMALES.

I. Anal grooves closed, oval and pointed behind; coxa I without internal spur .. .. .. *holocyclus.*

II. Anal grooves open and divergent behind; coxa I with internal spur.

A. Coxa I with two strong, sub-equal spurs; punctations few and sparsely scattered; palpal article II twice as long as article III *acutitarsus.*

B. Coxa I with two markedly unequal spurs, the external being short or obsolete; punctations numerous and close-set; palpal articles II and III sub-equal.

I. Scutum sub-pentagonal in shape; internal spur on coxa I comparatively long, external spur obsolete; postero-internal angles of coxae II and III sub-dentate .. .. .. *ricinus.*

II. Scutum elongate-oval in shape; internal spur on coxa I comparatively short, external spur short but prominent; postero-internal angles of coxae II and III without any such processes .. *granulatus.*

Ixodes ricinus (Linnaeus).

1911. *Ixodes ricinus*, Nuttall and Warburton, *Ticks* part 2, pp. 143-156, pls. iv, vii, text-figs. 115, 139-148.
1911. *Ixodes ricinus*, Neumann, *Das Tierreich* XXVI, pp. 12, 13, text-figs. 1-6.
1927. *Ixodes ricinus*, Ogura and Takada, *Journ. Coll. Agric. Hokkaido Imp. University* XVIII, pp. 199-201, pl. xi.

Male.—It agrees fairly well with Nuttall and Warburton's description of the male of *I. ricinus*, only differing from it in having an ill-defined pseudo-scutum of Sanford's brown colour and well developed, deep cervical grooves. The rest of the scutum is auburn in colour. The only male specimen in the collection measures $2{\cdot}2 \times 1{\cdot}6$ mm. and its scutum is $2{\cdot}1 \times 1{\cdot}3$ mm. in size. The pad attains more than two-thirds the length of the claws.

Female.—It agrees with Nuttall and Warburton's description of the female of this species but differs from it in having its scutum nearly as broad as long. In the two female specimens before me the scutum measures as follows:—

Length		Breadth
1·6 mm.	.. ..	1·6 mm.
1·6 mm.	.. ..	1·5 mm.

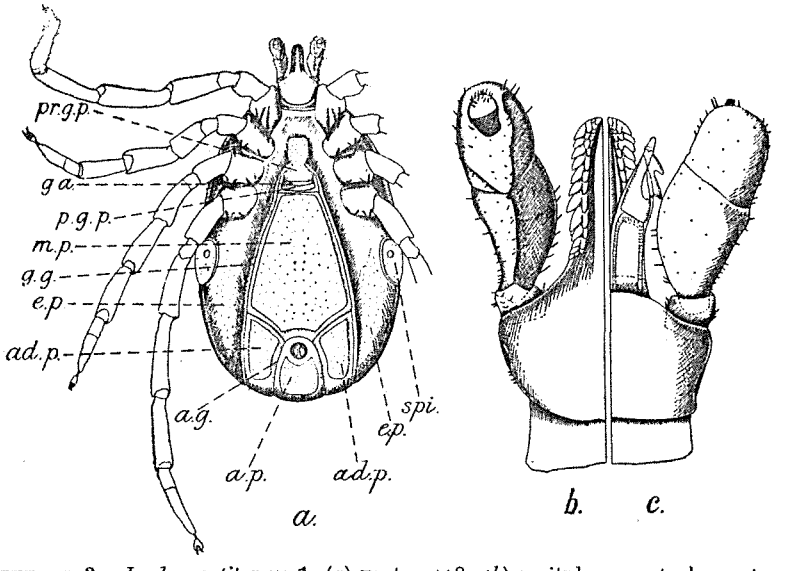
Distribution and hosts.—This species has a fairly wide distribution and, as pointed out by Senevet and Rossi (1926), it is found only in cold and temperate regions. It is common throughout the whole of Europe, but in Asia it has been recorded from Japan, Annam, India (only one lot of ♀s off a dog from Kashmir), Arabia, Asia Minor and Transcaucasia, in Africa from Algeria, Tunisia and Libya and in America from the United States, British Columbia, Porto Rico and Panama. Miller (1922) and a few other authors record its presence in New Zealand but it is doubtful whether the records by these authors are based on authentically identified specimens. I have examined ♂♀s off a sheep found grazing on the hill side near Kareri Lake (alt. 10,000 ft.) in the Kangra Valley, Western Himalayas.

Ixodes acutitarsus (Karsch).

1880. *Haemalastor acutitarsus*, Karsch, *Mittheil. Münchener Entomol. Vereine* IV, p. 142.
1899. *Ixodes laevis*, Neumann, *Mém. Soc. Zool. France* XII, pp. 148, 149, text-fig. 21.
1899. *Haemalastor acutitarsus, id., ibid.*, p. 180.
1901. *Ixodes acutitarsus*, Neumann, *Mém. Soc. Zool. France* XIV, pp. 285, 286.
1901. *Eschatocephalus acutitarsus, id., ibid.*, p. 290.
1910. *Ixodes gigas*, Warburton, *Parasitology* III, pp. 397, 398, text-figs. 1, 2.
1911. *Ixodes acutitarsus*, Neumann, *Das Tierreich* XXVI, p. 16.
1911. *Ixodes acutitarsus* and *Ixodes gigas*, Nuttall and Warburton, *Ticks* part 2, pp. 202-204, text-figs. 195, 196.
1916. *Ixodes acutitarsus* and *Ixodes gigas*, Nuttall, *Parasitology* VIII, pp. 325, 327.

After examining the type-specimen of the male of this species I find that Warburton's description of *I. gigas* is defective in certain points and hence I give below the amended description of the same.

Male.—The scutum is smooth with very fine, sparsely scattered punctations all over, but they are more pronounced and abundant on the scapulae and between the cervical grooves. The lateral grooves, which according to Warburton are absent, are well indicated in the type-specimen : they are continuous and narrow and each runs parallel to the margin of the scutum from a point a little behind the scapula of the side. A broad depression extends outwards and forwards from the middle of the cervical groove to the antero-lateral margin of the scutum. The venter is slightly hairy. The pre-genital plate exhibits a constriction in its posterior



TEXT-FIG. 3.—*Ixodes acutitarsus* ♂: (*a*) venter, ×8 ; (*b*) capitulum, ventral aspect, ×36 ; (*c*) capitulum, dorsal aspect, ×34.

a.g. anal groove ; *a. p.* anal plate ; *ad. p.* adanal plate ; *e. p.* epimeral plate ; *g.a.* genital aperture ; *g. g.* genital groove ; *m. p.* median plate ; *p. g. p.* post-genital plate ; *pr. g. p.* pre-genital plate ; *spi.* spiracle.

third. The posterior lip of the genital aperture is strengthened by a short transverse chitinous plate as in many other genera of the family

Ixodidae. The anal groove is rounded in front and its posterior limbs are slightly divergent behind. The coxal armature, as pointed out by Warburton, is like that of a *Rhipicephalus* or *Hyalomma* ; coxa I has two long, sub-equal and pointed spurs which overlap coxa II. Coxae II-IV possess two short spurs each ; the external is pointed, narrow and a little longer than broad and the internal short and broad, ridge-like.

The capitulum is 1·5 mm. in length. The base is trapezoid with the lateral sides slightly converging posteriorly ; it is less than twice as broad as long. The palps are about three times as long as broad. Article II has a slight external concavity and usually bears six very small simple hairs on the supra-internal margin. Article III has a ventral blunt retroverted spur-like prominence. Article IV is very small and bears about fifteen sensory hairs at its tip. The hypostome has 2|2 rows of teeth with about ten teeth in each row ; those in the external row are much larger than those in the internal. The external cheliceral article possesses two cusps and the dorsal process is elongate and has three cusps, the middle one being the largest.

Female.—The smaller of the two females in the Indian Museum collection is 4·5 × 3·5 mm. in size. The scutum is broader than long. The following are the measurements of the scutum of the two specimens examined :—

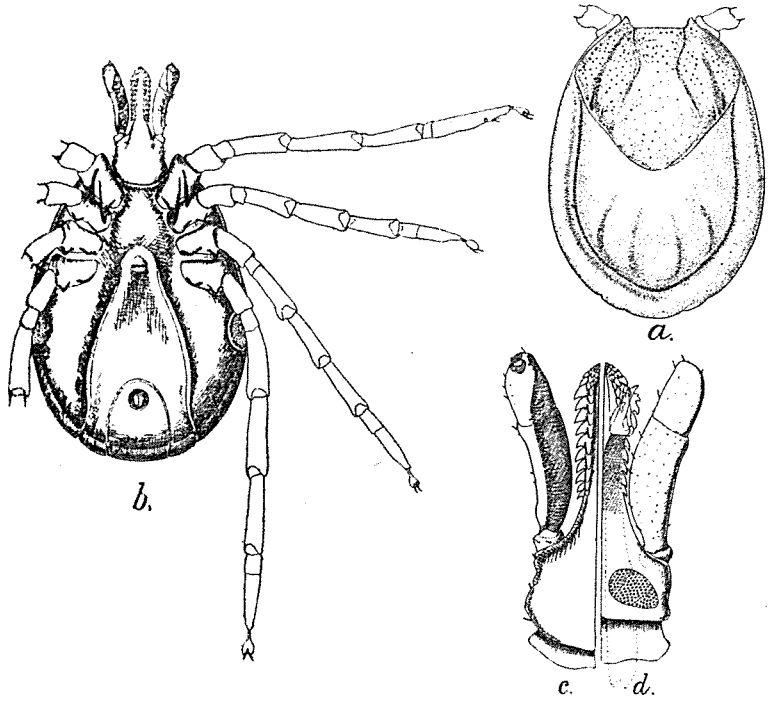
		Length	Breadth
Reg. No. $\frac{1248}{17}$ .. .. Yembung		2·2 mm.	2·4 mm.
Reg. No. $\frac{8782}{H\ 2}$ .. .. Miri Hills		2·3 mm.	2·7 mm.

The punctations are fine, sparsely scattered, rare on the median field, but abundant on the lateral fields. The dorsum has fine shallow punctations and is of a Dresden-brown colour. The genital aperture lies opposite the inter-coxal space between coxae III and IV and the anal groove has its posterior limbs divergent as in the male. The coxal armature is as in the male.

The capitulum is twice as long as broad and is 1·68—1·95 mm. in length. The base is sub-rectangular and is about twice as broad as long. The interval between the porose areas is less than the smallest diameter of these areas. The palps are four times as long as broad. Article I is visible both dorsally and ventrally and has a slight external salience. Article II is about three times as long as broad with a markedly concave external border. Its dorsal surface is twice as broad as the ventral and its supra-internal margin is provided with five very short hairs. Article IV is much reduced and is terminal in position. It bears about fifteen small sensory hairs. The hypostome is as in the male. The external cheliceral article has five cusps. The dorsal process is elongated with its two ends bent so as to form a curve.

I have re-examined the type of *I. gigas* Warburton and find that its coxal armature, capitulum and general appearance are similar to those of *I. acutitarsus*. I am, therefore, of opinion that *I. gigas* is based on the male of *I. acutitarsus*, which was hitherto unknown. This was suggested

by Nuttall and Warburton (1911, p. 204) and has also been confirmed by Mr. Warburton himself, who from the examination of some material



TEXT-FIG. 4.—*Ixodes acutitarsus* ♀: (*a*) dorsum, × 9; (*b*) venter, × 9; (*c*) capitulum, ventral aspect, × 20; (*d*) capitulum, dorsal aspect, × 20.

sent to him by Dr. C. Strickland, Professor of Entomology, Calcutta School of Tropical Medicine and Hygiene, and including both the males and females collected from the same host, came to the conclusion that *I. gigas* is the male of *I. acutitarsus*.

Distribution and hosts.—This species has so far been recorded from Japan, S. Formosa, Upper Burma, Sikkim and the Abor country. Warburton's type-specimen of *I. gigas* (Reg. No. $\frac{1103}{17}$) which is in the Indian Museum collection is from Punkabari in the Darjeeling District. Nuttall has recorded its occurrence on a man from the Salween Valley, 700-800 ft. at Chamuteng, Tibet. I also refer to this species a ♀ taken off an ox from the Miri Hills in the Abor country, N. E. Frontier, Upper Assam. The accompanying label in the tube states that the species is "common in the Miri Hills and is rather difficult to dislodge from the host."

Ixodes granulatus Supino.

1911. *Ixodes granulatus*, Neumann, *Das Tierreich* XXVI, pp. 20, 21.
1913. *Ixodes kempi*, Nuttall, *Parasitology* VI, pp. 131-133, text-fig. 1.
1916. *Ixodes granulatus*, Nuttall, *Parasitology* VIII, pp. 315, 316, text-fig. 17.

Male.—Unknown.

Female.—The smallest female in the Indian Museum collection is almost unfed and measures 1·75 × 1·2 mm. in size. Its body is oval,

narrowing considerably towards the anterior end and is broadest opposite the spiracle. The scutum is longer than broad and its measurements are as follows:—

		Length	Breadth
Reg. No. $\frac{9991}{17}$	.. Kohima, Naga Hills ..	.. {1·2 mm. / 1·3 mm.	0·8 mm. / 0·9 mm.
Reg. No. $\frac{2345}{17}$	.. Pashok, Darjeeling District	.. {1·2 mm. / 1·3 mm.	0·8 mm. / 0·93 mm.
Reg. No. $\frac{1247}{17}$	.. Kobo in Abor country ..	.. 1·5 mm.	1·1 mm.

The dorsum is strongly hairy and is of a Sudan-brown colour. The marginal groove is complete and present in the unfed female but disappears in the fed ones. The limbs of the anal groove are sub-parallel but meet each other in front of the anus in the form of a regular curve. They reach the posterior margin of the body but are shallow posteriorly.

The capitulum is 0·75—0·8 mm. in length. Its base is sub-triangular. The porose areas are very large and the interval between them is equal to half their largest diameter. The cornua are short and obsolescent. The palps are four times as long as broad with articles II and III subequal. Article II has four simple, very small hairs on the supra-internal margin. The hypostome is long and pointed anteriorly and the corona is obsolete; it is armed with 2|2 to 3|3 rows, each of about eleven unequal teeth. The external cheliceral article has six cusps, progressively increasing in size from the distal end to the proximal. The dorsal process is long and sigmoid-shaped.

From a careful examination of the type-specimens of *I. kempi* Nuttall I find that they do not differ in any respect from *Ixodes granulatus* and hence this species must be relegated to the synonymy of the older species *I. granulatus* Supino.

Distribution and hosts.—The species has previously been recorded from Java and Burma. In Indian limits it has been taken off *Epimys rufescens* at Pashok in the Darjeeling District. Nuttall's type-specimens of *I. kempi* (Reg. No. $\frac{1247}{17}$) were taken off *Sciurus erythraeus intermedius* from Kobo in the Abor country. I have examined specimens (♀s, off squirrel) from Kohima in the Naga Hills District, Assam.

Genus **Haemaphysalis** Koch.

1915. *Haemaphysalis*, Nuttall and Warburton: in Nuttall, Warburton, Cooper and Robinson, *Ticks: A Monograph of the Ixodoidea*, part 3, pp. 349-352 (Cambridge).
1916. *Haemaphysalis*, Nuttall, *Bull. Entom. Research* VI, p. 139.
1918. *Alloceraea*, Schulze, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1918, pp. 62, 63.

Though the majority of the Indian species of ticks belongs to this genus, *H. bispinosa* Neumman is the only one which is common and widely distributed and which is of economic importance.

The ticks belonging to this genus are of small size and have developed various devices for adequate fixation to the host. The palps, as has already been pointed out (*vide supra*. p. 220), show great modifications. The claws are comparatively shorter than in the other genera but the

ventral trochantal spurs, when present, assist in taking a firm hold of the host. The ventral plate on the first palpal article in both the sexes and the post-genital plate in the male are absent in this genus.

I do not agree with Schulze in regarding *Alloceraea* Schulze (1918) as a valid genus. He considers it to be intermediate between the genera *Haemphysalis* Koch and *Aponomma* Neumann, and he proposed it for the *Aponomma*-like species *H. inermis* Birula. The differentiating characters of the genus *Alloceraea* as given by Schulze are " An *Aponomma* (bzw. *Amblyomma*) erinnern in beiden Geschlechtern die langen, im zweiten Glied nicht vorspringenden Palpen, das Fehlen des Harrfächers auf Glied zwei, der durch wenige Borsten ersetzt ist, und der Rüssel mit der an der Basis in Platten übergehenden Bezahnung, beim ♂ ferner der Verlauf der Genital und Analfurchen und das Stigma, an *Amblyomma* endlich die im Gegensatz zu Nuttall's Angaben auch nach innen scharf abgesetzten Randschildchen ". These characters are, however, present in many other species of the genus *Haemaphysalis*. The palps, according to Nuttall and Warburton, are long and are without lateral saliences in the female of *H. formosensis* Neumann. The paucity of hairs on palpal article II and the *Amblyomma*-like hypostome of *H. inermis* are apparently due to the peculiar blood-sucking habit of the species. The anal and genital grooves of the above type are found in most species of the genus *Haemaphysalis*. The elongated spiracle of *H. inermis* to some extent approaches in shape the spiracle of *H. cornigera* var. *anomala* Warburton and certain other species of the genus. Finally the scutes are quite distinct in *H. campanulata* Warburton. As stated by Warburton[1] " The genera *Haemaphysalis* and *Aponomma* have normally little in common, except the negative characteristics of the absence of eyes and anal plates." In my opinion there is absolutely no relationship between the genera *Aponomma* and *Haemaphysalis* and the creation of a new genus *Alloceraea* for *Haemaphysalis inermis* Birula, which Nuttall and Warburton rightly referred to the genus *Haemaphysalis*, is quite unjustified and this name should be relegated to the synonymy of *Haemaphysalis* Koch.

Neumann (1901, p. 340) suggested *Haemaphysalis concinna* Koch as the geno-type of the genus *Haemaphysalis* Koch, but it was changed by Nuttall and Warburton (1915, p. 352) to *H. cinnabarina* Koch, which, however, is not permissible according to Article 30g (type by subsequent designation) of the " International rules of Zoological nomenclature."

The following key to the Indian species is based mainly on Nuttall and Warburton's excellent key to the genus. It has, however, been considerably modified in order to facilitate the identification of the Indian species :—

MALES.

I. Lateral grooves either absent or represented by very short ill-defined depressions dorsal to the spiracles.
  A. Lateral grooves represented by short obsolete depressions situated dorsal to the spiracles ; palpal article II without any ventral retroverted spur .. .. *turturis.*

[1] Warburton, *Parasitolgy* VI. p. 130 (1913).

B. Lateral grooves totally absent; palpal article II with a short ventral retroverted spur.
I. Palpal article III with a dorsal retroverted spur; article II with a lobe-like projection on the spura-internal margin — *hystricis.*
II. Palpal article III without a dorsal retroverted spur; article II with no such projection .. .. .. — *birmaniae.*

II. Well-defined lateral grooves present.
A. One or more coxae strongly spurred.
I. All coxae and trochanters with strong subequal spurs; a strong ventral retroverted spur on article II proper and not on its lateral salience which is slight .. — *montgomeryi.*
II. Coxae II and III only feebly spurred; ventral trochantal spurs obsolete or poorly developed; article II either without well developed ventral retroverted spur or if present situated on its lateral salience which is generally strong.
A. Coxa IV with two long spurs.
1. Palpal article III with a long lateral spur; lateral grooves short .. .. — *cornigera* forma *typica.*
2. Palpal article III with a rudimentary lateral spur; lateral grooves long .. — *cornigera* var. *anomala.*
B. Coxa IV with one long spur.
1. Coxae I and IV each with a long spur; a ventral retroverted spur on the lateral salience of article II .. — *spinigera.*
2. Only coxa IV with a stout long tapering spur; no ventral retroverted spur on the lateral salience of article II — *flava.*

B. Coxal armature normal and inconspicuous.
I. Palpal article III with dorsal retroverted spur more or less erect.
A. Cornua very strong, as long as basis capituli.
1. Palpal article II much longer than article III .. — *aculeata.*
2. Palpal articles II and III sub-equal. .. .. — *cuspidata.* [1]
B. Cornua moderate.
1. Comparatively large species; scutum finely punctate; dorsal spur on palpal article III in the middle and its ventral retroverted spur comparatively short.
a. Dorsal spur on article III long and prominent .. — *bispinosa* forma *typica.*
b. Dorsal spur on article III broad, ridge-like and obsolete. .. — *bispinosa* var. *intermedia.*
2. Comparatively small species; scutum coarsely punctate; dorsal spur on palpal article III internal in position and its ventral retroverted spur comparatively long .. — *parva.*

[1] For the description of *H. cuspidata* Warburton see Nuttall and Warburton, *Ticks* part 3, pp. 438-440, text-figs. 367-370 (Cambridge, 1915).

II. Palpal article III with no such spur.
A. Palps only slightly salient laterally; (hypostome 6|6 ; trochantal spur slight) .. .. .. *formosensis.*[1]
B. Palps strongly salient laterally.
1. Scutum markedly elongate; palps short, cone-shaped, as broad as long and meeting each other at an obtuse angle; lateral salience of article II with dorsal and ventral retroverted spurs.
a. Retroverted spurs on the salience of article II strongly developed, the ventral being longer than the dorsal; punctations comparatively numerous; cornua long and pointed .. *leachi* forma *typica.*
b. Retroverted spurs on article II obsolete and sub-equal; cornua short and blunt; punctations few and sparsely scattered .. *leachi* var. *indica.*
2. Scutum short, oval; palps much longer than broad and not meeting each other at an obtuse angle; lateral salience of article II without retroverted spur.
a. Dorsal postero-internal angle of palpal article III produced into a retroverted process .. *wellingtoni.*
b. No such process on article III, its posterior border straight.
i. Hypostome 6|6; tarsi tapering .. *howletti.*[2]
ii. Hypostome 4|4; tarsi humped .. *campanulata.*

FEMALES.

I. Palps not salient laterally, not wider than basis capituli.
A. Capitulum *Aponomma*-like without ventral and dorsal retroverted spurs on palps; coxa I with obsolete spur; scutum broadest in the anterior third and narrowing considerably towards the posterior end; hypostome 3|3 .. .. .. *inermis* var. *aponommoides.*
B. Capitulum not *Aponomma*-like, with a ventral retroverted spur on article III; coxa I with a fairly well-developed spur; scutum broadest in the middle but narrowing towards the posterior end; hypostome 4|4 .. *formosensis.*

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[1] For the description of *H. formosensis* Neum. see Nuttall and Warburton, *Ticks* part 3, pp. 400-402, text-figs. 334, 335 (Cambridge, 1915).
[2] For the description of *H. howletti* Warburton see *id., ibid,* pp. 493, 494, text-figs. 433. 434 (Cambridge, 1915).
[3] For the description of *H. inermis* var. *aponommoides* Warburton see *id., ibid., Ticks* part 3, pp. 367—369, text-fig. 313 (Cambridge, 1915).

II. Palps more or less salient laterally.

A. Trochantal spurs distinct.

I. Trochanters all spurred; palps very slightly salient, a ventral retroverted spur on palpal article II proper .. *montgomeryi.*

II. Only trochanters II and IV with conspicuous spurs; palps strongly salient, palpal article II without ventral retroverted spur .. .. *howletti.*

B. Trochantal spurs feeble or absent.

I. Palpal article III with distinct dorsal retroverted spur, more or less erect.

A. Palpal article II much longer than article III .. .. *aculeata.*

B. Palpal articles II and III sub-equal.

1. Lateral salience of palpal article II with a ventral retroverted spur .. *spinigera.*

2. Lateral salience of palpal article II without such a spur.

a. Dorsal spur on palpal article III very strong; cornua very strong .. *cuspidata.*

b. Dorsal spur on palpal article III moderate or short; cornua moderate.

α Scutum longer than broad; comparatively small species.

* Dorsal spur on palpal article III in the middle and its ventral spur comparatively short.

† Dorsal spur on palpal article III fairly strong. .. *bispinosa* forma *typica.*

†† Dorsal spur on palpal article III broad, ridge-like and obsolete .. *bispinosa* var. *intermedia.*

** Dorsal spur on palpal article III internal in position and its ventral spur comparatively strong .. *parva.*

β Scutum at least as broad as long or broader than long; comparatively large species .. *hystricis.*

II. Palpal article III without such a spur but posterior border may protrude.

A. Palps short, cone-shaped, as broad as long.

1. Punctations comparatively numerous; lateral salience on article II with short but distinct dorsal and ventral retroverted spurs; hypostome generally more than 4|4 .. *leachi* forma *typica.*

2. Punctations comparatively few; lateral sallence on article II with obsolete dorsal and ventral retroverted spurs; hypostome 4|4 .. *leachi* var. *indica.*

B. Palps much longer than broad.

1. Palpal articles II and III equal; article III with postero-internal angle on the dorsal surface produced into a well-developed process .. *wellingtoni.*

2. Palpal articles II and III generally unequal and article III without such a process.

a. Scutum broader than long.

i. Palpal article II widest distally; punctations large *kinneari.* [1]

ii. Palpal article II widest in the middle or near the base, punctations fine .. .. *birmaniae.*

b. Scutum generally longer than broad or as long as broad.

i. Porose areas large and the interval between them much less than their diameter: coxal armature less developed than the normal type .. *sewelli.*

ii. Porose areas small and the interval between them more than their diameter; coxal armature normal.

α Hypostome 6|6 or 7|7; lateral salience slight *sundrai.*

β Hypostome less than 6|6; lateral salience well marked.

* Palpal article III with ventral retroverted spur poorly developed; scutum as long as broad, broadest in the middle .. *flava.*

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[1] For the description of *H. kinneari* Warburton see Nuttall and Warburton *Ticks* part 3, pp. 397, 398, text-fig. 332 (Cambridge, 1915).

** Palpal article III with ventral retroverted spur well developed ; scutum longer than broad, broadest in the anterior half.	
† Scutum cordate, narrowing posteriorly ; tarsi humped ; lateral salience on article II sharply pointed.	
§ Lateral salience on article II with a lobe-like ventral retroverted process	*choprai.*
§§ Lateral salience on article II without such a process	*campanulata.*
†† Scutum oval ; tarsi tapering gradually ; lateral salience on article II ends broadly.	
§ Punctations on the scutum numerous and deep ; the lateral contour of article II not continuous with that of article III	*cornigera* forma *typica.*
§§ Punctations on the scutum less numerous and superficial ; the lateral contour of article II continuous with that of article III	*cornigera* var. *anomala.*

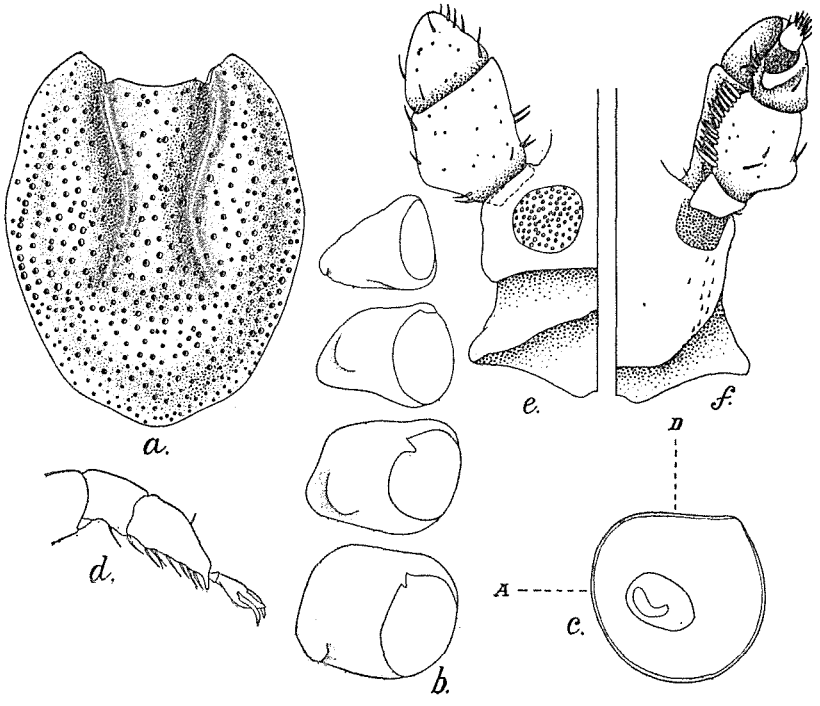
Haemaphysalis sewelli, sp. nov.

Male.—Unknown.

Female.—The scutum is long and oval and is broadest in the middle of its length. The punctations are fine, very numerous, close-set and deep. The cervical grooves are deep and narrow with an external concavity and extend over a little more than half the scutum. The following measurements give the size of the scutum of the two females from Abbottabad.

Length	Breadth
1·3 mm...	1·1 mm.
1·4 mm...	1·13 mm.

The spiracle is sub-circular with the dorsal and posterior sides almost straight: its postero-dorsal protuberance is almost obsolete. The legs are hairy. The coxae increase gradually in size towards the posterior end. Coxa I has a very short spur on the internal angle and coxae II and III each exhibits a trace of a broad ridge-like spur. Coxa IV possesses a very short and somewhat narrow spur near the internal angle. Tarsus IV tapers gradually to a long ventral spur. The pad attains more than half the length of the claws.



TEXT-FIG. 5.—*Haemaphysalis sewelli* ♀: (*a*) scutum, × 36; (*b*) coxal armature, × 36; (*c*) spiracle, × 55; (*d*) tarsus IV, × 36; (*e*) capitulum, dorsal aspect, ×55; (*f*) capitulum, ventral aspect, ×55.

The capitulum is 0·66 mm. in length. The base is thrice as broad as long, and the cornua are poorly developed. The porose areas are large and sub-circular with the interval between them equal to half the diameter. There is a depression between the porose areas. The palps are twice as long as broad. Article I is distinctly visible ventrally and bears a simple hair on its infra-internal margin. Article II is slightly longer than broad and is without any well-defined ridge, and the lateral salience is slight. It bears four short simple hairs on the supra-internal margin and about thirteen short feathery hairs on the infra-internal margin. Article III is triangular in shape and possesses a very short blunt ventral retroverted spur. The hypostome is unfortunately missing in both the type-specimens. The external cheliceral article has three cusps, the distalmost being very small and sub-ventral in position.

I have dedicated this species to Lt.-Col. R. B. Seymour Sewell, Director, Zoological Survey of India. The type-specimens, 2 ♀s (Reg. No. $\frac{27}{18}$) taken off a goat at Abbottabad, Hazara Dist., N. W. Frontier Province, are in the Indian Museum. This species is allied to *Haemaphysalis cinnabarina* var. *punctata* (Canestrini and Fanzago), but differs from it in the following points.

(1) The scutum exhibits the greatest breadth in the middle of its length instead of being broadest in the anterior one-third. The punctations are finer and more numerous than those in *H. cinnabarina* var. *punctata*.

(2) The shape of the spiracle is slightly different.

(3) The coxal armature is less developed than in *H. cinnabarina* var. *punctata*.

As regards the scutum, the punctations and the spiracle this species resembles *H. howletti* Warburton but is quite different from the latter in other respects.

Haemaphysalis sundrai, sp. nov.

Male.—Unknown.

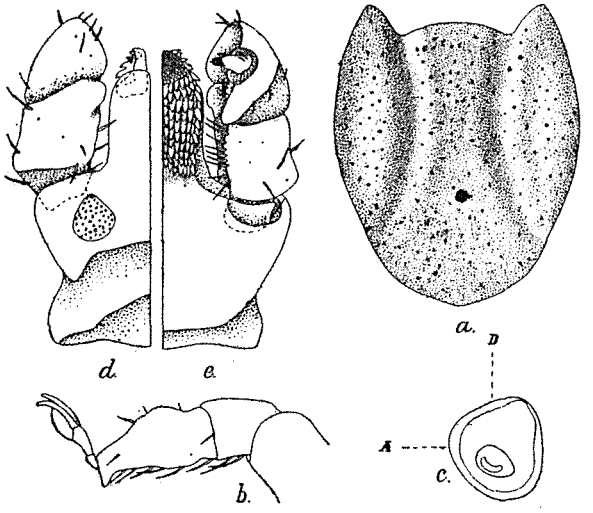
Female.—The scutum is oval and is broadest in its anterior half. The cervical grooves, which are sub-parallel, reach the posterior margin of the scutum. The punctations are sparsely scattered and are superficial. The following are the measurements of the scutum of the three females in the collection which I have examined.

Length					Breadth
1·2 mm...	..	..	..	..	1·1 mm.
1·2 mm...	..	..	..	..	1·1 mm.
1·3 mm...	..	..	..	..	1·1 mm.

Each marginal groove includes two festoons of the side. The spiracle is pear-shaped with the dorsal and posterior sides almost straight. The coxal armature is normal. The ventral trochantal spurs are poorly developed. The tarsi are slightly humped prior to tapering into a ventral spur. The pad attains two-thirds the length of the claws.

The capitulum is 0·55 mm. in length. The lateral sides of the base converge posteriorly; it is three times as broad as long and the cornua are strong. The porose areas are sub-triangular with the interval between them more than their maximum width. The palps are twice as long as broad and article I is partially fused with article II. Article II is twice as long as article III; it has on its posterior half a dorsal ridge which is continued round the external side into a strong ventral ridge. The lateral salience, which lies in the proximal half, is slight. It possesses about nine slightly feathery hairs on the infra-internal margin and two simple hairs on the supra-internal margin. Article III is as broad as long and has a strong ventral spur which is directed obliquely inwards and backwards. The hypostome is armed with 6|6 or 7|7 rows of teeth with about ten teeth in each. The external cheliceral article exhibits five cusps, the three distal being small and sub-ventral in position.

The species is described from three females (Reg. No. $\frac{28}{18}$) taken off a sheep by Dr. Sundra Rao at Bhowali, alt. 6,000 feet, in the Naini-Tal



TEXT-FIG. 6.—*Haemaphysalis sundrai* ♀: (*a*) scutum, × 25; (*b*) tarsus IV, × 36; (*c*) spiracle, × 36; (*d*) capitulum, dorsal aspect, × 56; (*e*) capitulum, ventral aspect, × 56.

District, United Provinces. It is named after the collector and the type-specimens are deposited in the Indian Museum.

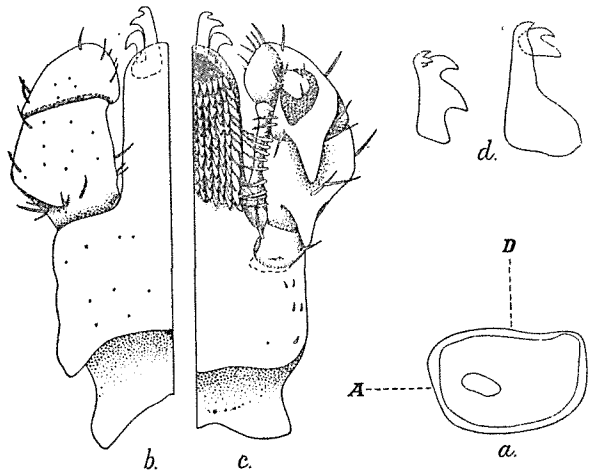
Haemaphysalis montgomeryi Nuttall.

1915. *Haemaphysalis montgomeryi*, Nuttall and Warburton, *Ticks* part 3, pp. 395-397, text-figs. 330, 331.

Male.—The body is elongated and oval, being broadest near the middle. Its size varies from 1·66 × 1·25 mm. to 2·7 × 1·96 mm. The scutum is strongly convex dorsally: its colour is generally buckthorn-brown but is cinnamon-brown in highly chitinised specimens. The punctations are numerous, close-set, fine and equal. The cervical grooves are short and sub-parallel. The lateral grooves are narrow and deep anteriorly, becoming broad and shallow posteriorly. In the larger specimens there are lateral extensions of the body beyond the scutum. The venter is either light brown or pale yellow. The spiracle is trapezoid-oval in shape with a very slight postero-dorsal extension and is longer than broad. The legs are strongly hairy. The coxae are as broad as long and gradually increase in size from before backwards. The spur on coxa IV is the longest and not that on coxa I, as stated by Nuttall. The distal portion of tarsus IV is one and a half times as long as the proximal portion and it tapers gradually to a short ventral spur. The ventral surface of the distal portions of all the tarsi is strongly serrated.

The capitulum is longer than broad. Its length varies from 0·35 mm. to 0·5 mm. The base is twice as broad as long with the lateral sides slightly irregular. The cornua are strong and pointed. The palps are twice as long as broad with slight lateral saliences in the middle

of article II. Article I is not visible dorsally but nearly the whole of it is visible ventrally; it bears a single long hair on its infra-internal margin,



TEXT-FIG. 7.—*Haemaphysalis montgomeryi*: (*a*) ♂, spiracle, × 56; (*b*) ♂, capitulum, dorsal aspect, × 92; (*c*) ♂, capitulum, ventral aspect, × 92; (*d*) ♀, ventral view of the left digit, × 150.

and is as broad as long. Article II is slightly longer than broad with a slight blunt and broad backwardly directed process in the posterior third of its dorsal aspect and a strong retroverted spur ventrally. It bears seven to nine slightly feathery hairs on the infra-internal, and three simple hairs on the supra-internal margins. Article III is broader than long and bears a strong conical and retroverted spur ventrally. The hypostome is armed with 5|5 to 7|7 rows of teeth, with about eleven long pointed teeth in each row. The external cheliceral article possesses a single cusp.

Female.—The smallest female specimen, which appears to be almost unfed, is 2·4 × 1·4 mm. in size; when replete it becomes as much as 7·5 × 5·0 mm. The body is elongate-oval in shape, narrowing gradually towards the anterior end. The marginal grooves are deep and narrow and each includes the two anterior festoons. The postero-median and postero-lateral grooves are broad and shallow. The scutum is nearly as broad as long and varies from 0·95 × 0·83 mm. to 1·2 × 1·05 mm. in size. It is sub-cordiform, being broadest in its anterior third. The cervical grooves are sub-parallel with a slight external concavity. They extend backward into the posterior half of the scutum and in a few cases they even reach the posterior margin. The punctations are fine, equal and sparsely scattered all over the scutum. The venter is slightly hairy and the spiracle is as long as broad with the dorsal and posterior sides almost straight. The serration on the ventral surface of the distal portion of the tarsi is obsolete.

The capitulum of the female is in comparison stronger than that of the male, and its length varies from 0·46 mm. to 0·55 mm. The base is broader than that of the male. The cornua are short and blunt. The porose areas are oval and the interval between them is greater than

their largest diameter. The dorsal retroverted spur on palpal article II is absent and the ventral retroverted spur is shorter than that of the male. The external cheliceral article has five cusps, the three distal being very small and sub-ventral in position. The dorsal process is crescentic in shape with its dorsal limb much the longer.

The strong spurs on the palps and trochanters, the hairy ventral surface and the legs in this species are adaptations to ensure a strong hold on the hairy host.

Distribution and hosts.—From the existing records it appears that the species has a very wide range of distribution and is confined to hill areas. It has so far been recorded from Almora and Naini-Tal Districts in the United Provinces, the Central Provinces and Kashmir. It appears to be a parasite of domestic animals in the hilly regions and consequently is of some economic importance.

United Provinces :—Bhim Tal, alt. 4,500 ft. (♂s ♀s, off cattle) and Bhowali, alt. 6,000 ft. (♂s ♀s, off sheep and ♂s ♀s, off cattle) both in the Naini-Tal District.

Punjab :—On hill-side, below Phagu, alt. 7,000 feet. (♂, off sheep) and Kasauli (♂ ♀s, off leopard, Kasauli Coll.), both in the Simla Hills, Western Himalayas.

Haemaphysalis flava Neumann.

1915. *Haemaphysalis flava*, Nuttall and Warburton, *Ticks* part 3, pp. 408-410 text-figs. 342, 343.

1917. *Haemaphysalis flava*, Paoli, *Boll. Mus. Zool. Anat. Comp. Torino* XXXII, pp. 2, 3, text-figs. 2, 4.

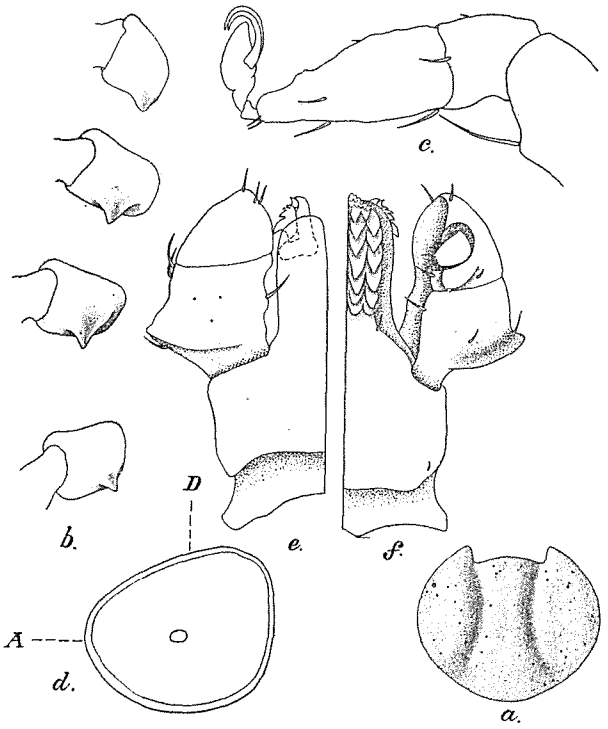
Male.—The size of the male is 2·8 mm. in length and 1·9 mm. in breadth. The punctations are fine, sparsely scattered and almost superficial. The lateral grooves show some variation in size but are generally short. The posterior dorsal grooves are well indicated in the specimens that I have examined. The spiracle is ovoid with the posterior and dorsal sides straight; its dorsal extension is obsolete. Coxa I has a short blunt spur on the internal angle and coxae II and III have each a short pointed spur near the middle. The spur on coxa IV is very long and is equal to about half the breadth of the coxa. Tarsus IV tapers gradually into a short ventral spur which is preceded by a similar but smaller spur near the proximal end of the distal portion. The pad attains more than three-fourths the length of the claws.

The capitulum is 0·52 mm. in length. The palps are one and a half times as long as broad. Article I is almost fused with article II, which is one and a half times as long as article III. The second article possesses a dorsal ridge; this ridge is continued round the lateral salience into a ventral ridge which terminates in a short retroverted spur. This article bears three slightly feathery hairs on the infra-internal margin and two on the supra-internal margin. Article III is half as long as broad and bears a short retroverted spur. The hypostome has 5|5 rows of teeth, each row having about eight teeth. The external cheliceral article has four cusps, the three distal being very small and the distalmost sub-ventral in position.

Female.—The scutum is sub-circular in shape, being broadest in the middle of its length. Its size varies from 1·0×1·2 mm. to 1·2×1·2 mm.

The coxal armature is as in the male, with the exception of the spur on coxa IV which is comparatively short.

The capitulum is 0·5 mm. in length and the base is three times as broad as long. Article II shows no indication of a ventral retroverted spur. The hypostome is generally armed with 4|4 rows of teeth, each row having about eleven rather strong teeth. The external cheliceral article exhibits five cusps, the three distal being very small and the distal-most being sub-ventral in position.



TEXT-FIG. 8.—*Haemaphysalis flava* nymph: (*a*) scutum, × 42; (*b*) coxal armature, × 53; (*c*) tarsus IV, × 135; (*d*) spiracle, × 135; (*e*) capitulum, dorsal aspect, × 163; (*f*) capitulum, ventral aspect, × 163.

Nymph.—The scutum is sub-circular, being broadest in the middle. It measures 0·48 mm. in length and 0·5 mm. in breadth. The cervical grooves are at first sub-parallel and deep, but posteriorly they diverge: they almost reach the posterior margin of the scutum. The spiracle is pear-shaped. Coxa I possesses a short blunt spur on the internal angle and coxae II-IV have each a short pointed spur near the middle of their length. Tarsus IV tapers gradually and is without ventral spurs. The pad attains about two-thirds the length of the claws.

The capitulum is 0·22 mm. in length. The base is three times as broad as long and has well-developed cornua as in the female. The palps are similar to those of the female, but the ventral retroverted spur of article III is blunt and very short. Article I is totally fused with article II. The hypostome has 2|2 rows of teeth with seven teeth in each row.

The type-specimen (Reg. No. $\frac{20}{18}$) of the nymph is in the Indian Museum.

Distribution and hosts.—This species has been recorded from Japan by Neumann. Paoli records it from the island of Rhodes in the Aegean Sea and Yakimoff (1917, p. 300) records it from Caucasia. In India Nuttall and Warburton have recorded it from Madras and Muktesar in the Naini-Tal District. Its record by Nuttall and Warburton [1] from Simla is incorrect as it is based on a specimen of *H. montgomeryi*. Other specimens of ♂s ♀s Os which I have seen were taken off a dog at Bhowali, Naini-Tal District, and are from the collection of the Calcutta School of Tropical Medicine and Hygiene. Dr. Strickland has kindly presented samples of both sexes and the type-specimen of the nymph to the Indian Museum. I have also determined several lots containing ♂s ♀s Os Ls, off jackal, fox, bullock, man and dog from Muktesar for the Imperial Veterinary Research Institute, Muktesar, Naini-Tal District, United Provinces.

Haemaphysalis turturis Nuttall and Warburton.

1915. *Haemaphysalis turturis*, Nuttall and Warburton, *Ticks* part 3, pp. 410, 411, text-fig. 344.

Male.—The scutum is either pale brown or brown in colour. The following measurements show the size of the males from two different places.

		Length	Breadth
Reg. No. $\frac{8915}{H\,2}$ .. Bhowali		1·9 mm.	1·35 mm.
		1·95 mm.	1·35 mm.
Reg. No. $\frac{8914}{H\,2}$ .. Parambikulam		2·1 mm.	1·35 mm.

The punctations are deep and numerous. The cervical grooves are represented by small oval sub-parallel pits. The festoons are approximately half as broad as long. The spiracle is elongate-oval in shape with a postero-dorsal extension. The tarsi taper rapidly and do not end in spurs. The pad reaches the tips of the claws.

The capitulum is from 0·36 to 0·43 mm. in length and its base is twice as broad as long, with the lateral sides almost straight. The palps are one and a half times as long as broad. Article I is visible ventrally and bears a single feathery hair. Article II has a fairly well-developed lateral salience and bears two simple hairs on the supra-internal and four feathery hairs on the infra-internal margin. It has a very prominent raised ventral ridge which is continued round the lateral salience into a dorsal ridge. Article III possesses a broad ridge-like dorsal retroverted spur. The external cheliceral article has four cusps of which the distal three are small and one of these is sub-ventral in position.

Female.—Unknown.

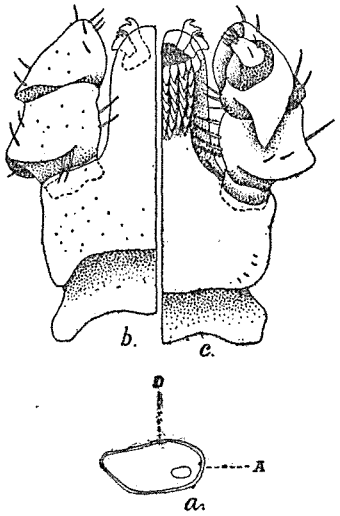
It is with some hesitation that I refer the five male specimens in the Indian Museum collection to this species since they differ in the following minor points from Nuttall and Warburton's description.

1. Punctations are not shallow but deep.

[1] Nuttall and Warburton, *Parasitology* III, p. 396 (1911).

2. The base of the capitulum is twice as broad as long, instead of being " not greatly broader than long " as stated by Nuttall and Warburton in the text. The figure published by them (fig. 344, p. 411) shows the proportion of length to breadth to be 8 to 5.
3. The posterior ventral border of article II does not end in a sharp point.

This species in general appearance closely resembles *Haemaphysalis bispinosa* var. *intermedia* Warburton and Nuttall from which, however, it differs in having ill-defined and short lateral grooves and moderately developed ventral trochantal spurs.



TEXT-fig. 9.—*Haemaphysalis turturis* ♂: (*a*) spiracle, × 55; (*b*) capitulum, dorsal aspect, × 85; (*c*) capitulum, ventral aspect, × 85.

Distribution and hosts.—The type-specimen, a single male, was taken off a dove (*Turtur suratensis*) from Ceylon. The following new records are from two widely separated places in India.

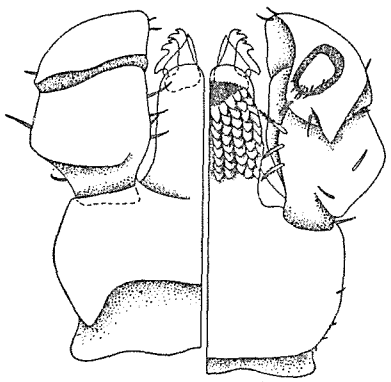
Madras Presidency :—Parambikulam in the Cochin State [♂s, off *Hemitragus hylocrius* (Ogilby), the Nilgiri wild goat].
United Provinces :—Bhowali in the Naini-Tal District (♂, off cattle).

Haemaphysalis birmaniae Supino.

1915. *Haemaphysalis birmaniae* and *Haemaphysalis aborensis*, Nuttall and Warburton, *Ticks* part 3, pp. 415, 416, 398, 399, text-figs. 348, 333.

Male.—The length of the scutum varies from 1·7 to 2·5 mm. and the breadth from 1·2 to 1·7 mm. The cervical grooves are represented by short slightly converging sub-oval pits which are in some cases continued posteriorly by narrow superficial diverging areas. The festoons are longer than broad. The leg segments are strong and massive. Coxa I is longer than broad and the others are progressively broader than

long from before backwards. The ventral trochantal spurs are poorly developed. The distal portion of tarsus IV is one and a half times as long as the proximal. It tapers rapidly to a small ventral spur which is preceded by a similar but a smaller one near the proximal end of the distal portion. The pad attains more than two-thirds the length of the claws.



TEXT-FIG. 10.—*Haemaphysalis birmaniae* ♂: (*a*) capitulum, dorsal aspect, × 105; (*b*) capitulum, ventral aspect, × 105.

The capitulum is 0·31—0·36 mm. in length. It is as broad as long. The base is about three times as broad as long with strong and pointed cornua. It is rectangular in shape with the lateral sides convex. The palps are slightly incurved at the tips and are one and a half times as long as broad. Article I is totally fused with article II which is twice as long as article III. Article II possesses about the middle of its length a dorsal ridge, which runs round the somewhat arched lateral salience, and is continued as a blunt ventral retroverted process, the latter being not so prominent as in *H. montgomeryi*. There are three to four simple hairs on its supra-internal, and about the same number of slightly feathery hairs on the infra-internal margin. Article III is half as long as broad and has a fairly well-developed ventral retroverted spur, but has no dorsal retroverted spur. The external cheliceral article has three cusps.

Female.—The smallest specimen in the collection is an almost unfed female measuring 2·5 ×1·9 mm. in size. The scutum is sub-circular and varies from 0·75 × 0·92 to 1·2 × 1·3 mm. The cervical grooves are narrow anteriorly and lead into broad oval slightly divergent pits, which hardly reach the posterior margin of the scutum. The scutum has a few sparsely scattered, fine and equal punctations. The emargination is moderately deep. The marginal grooves are narrow and deep and each includes the extreme festoon of the side. The spiracle is pear-shaped. The coxae are comparatively longer than those in the male, especially the second and third; these are longer than broad. Ventral trochantal spurs are absent.

The capitulum is stronger than that in the male, its length being 0·53 mm. The lateral margins of the base are less curved than those

in the male and the base itself is three times as broad as long. The cornua are short. The porose areas are small and oval in outline, with their longer axes converging anteriorly ; the interval between them is twice their shorter diameter and is somewhat depressed. The palps are not incurved, and are almost twice as long as broad. Article II has a slightly blunt lateral salience and the ventral backwardly directed process is not so pronounced as that of the male. The hypostome has 4|4 rows of teeth with about twelve teeth in each row. The external cheliceral article bears three cusps and the dorsal process is crescent-shaped, the dorsal limb being the longer.

After a careful examination of the type-specimen of *H. aborensis* Warburton I find that it does not differ in any respect from the female of *H. birmanice* Supino and should be included in the synonymy of the latter.

Distribution and hosts.—Supino's type-specimens of *H. birmaniae* (males only) are from Burma, while Warburton's type-specimen of *H. aborensis* is a ♀ from Yembung in the Abor country. From the following new records it is clear that the species is confined to the Eastern Himalayas and Burma. The detailed localities are :—

Burma :—Arakan Yomas, Chauung, Upper Myinudaung Reserve, ——— in the Henzada District (♂ [1], host unknown).

Assam :—Dikrang, Sadyia in the Lakhimpur District (♂ [1], host unknown).

Bengal :—Pashok in the Darjeeling District [♂s ♀s, off *Nemorhaedus bubalinus* Hodgson and ♀, off *Cervulus muntjac* Zimm.)].

Haemaphysalis hystricis Supino.

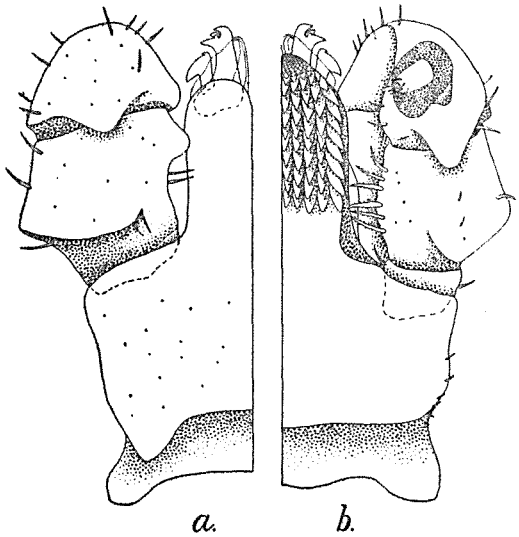
1915. *Haemaphysalis hystricis*, Nuttall and Warburton, *Ticks* part 3, pp. 422-426, text-figs. 354-357.

Male.—The punctations are fine and numerous, interspersed with a few larger ones scattered in between. The festoons are longer than broad, separated by broad grooves. The venter is slightly hairy. The coxae are nearly as broad as long and the coxal armature is comparatively less strong than that in *H. birmaniae*. The ventral trochantal spurs are very small and are sub-equal. The pad attains two-thirds the length of the claws.

The capitulum is from 0·5 mm. to 0·58 mm. in length. The palps are one and a half times as long as broad. Article I is distinctly visible ventrally and bears a simple hair on its infra-internal margin. Article II is the largest and possesses in the posterior half of its length a dorsal ridge which is continued round the lateral salience into a ventral ridge, which ends in a blunt backwardly directed process. There is a prominent lobe-like projection near the distal end of the supra-internal margin. It carries one or two simple hairs on the supra-internal and as many as six feathery hairs on the infra-internal margin. Article III has a moderately strong dorsal retroverted spur and a slightly longer

[1] These two males were identified and recorded as *H. hystricis* by Nuttall and Warburton [see *Ticks* part 3, p. 425 (1915)].

ventral retroverted spur. The external cheliceral article bears two cusps. the distal of which is very small.



TEXT-FIG. 11.—*Haemaphysalis hystricis* ♂: (*a*) capitulum, dorsal aspect, × 91; (*b*) capitulum, ventral aspect, × 91.

Female.—The scutum is either as bread as or broader than long, and its size varies from 1·2 × 1·4 mm. to 1·29 × 1·3 mm. Each marginal groove includes two festoons of the same side. The festoons are as long as broad.

The capitulum is comparatively strong and is 0·63 mm. in length. The base is three times as broad as long. The cornua are short and blunt. The porose areas are sub-circular and the interval betweed them is larger than their diameter. The palps are almost half as broan as long. The dorsal retroverted spur on article III is shorter than that in the male and the ventral retroverted spur on article II is short and broad. The internal lateral lobe on article II is either short or obsolete. The external cheliceral article possesses four cusps, the distal two being very small.

Distribution and hosts.—The species has previously been recorded from Formosa, Celebes, Borneo, Sumatra, China, the Federated Malay States, Burma, Assam and Ceylon. The new records are mostly from the Darjeeling District and the Abor country. It attacks mostly wild animals and is of very little economic importance.

? **Burma :**—(♀s, off *Geoemyda spinosa* Gray).

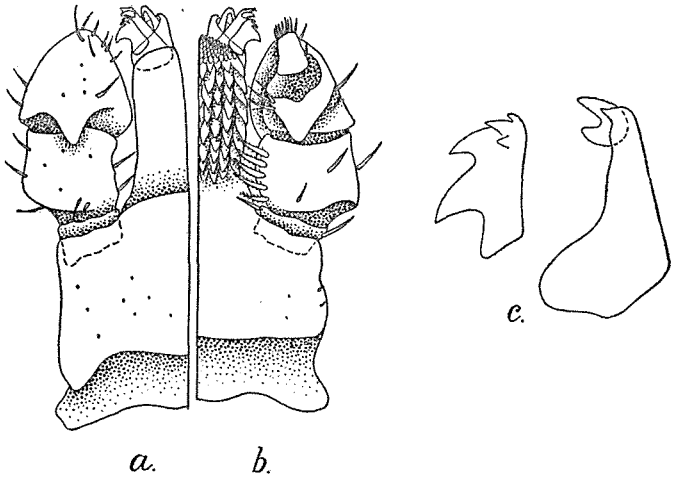
Assam :—Abor country between lat. 28° 45′ and 29°N., alt. 4,000 ft. (♂, host unknown). Nagabera in the Goalpara District (♂s ♀s, off *Felis tigris*).

Bengal :—Birch Hill, alt. 6 000-7,000 ft. (♂, host unknown), Pashok (two lots containing ♂s ♀s, host unknown) and Kalimpong, alt. 4 500 ft. (♀, host unknown), all three localities are in the Darjeeling District.

Haemaphysalis bispinosa Neumann.

1915. *Haemaphysalis bispinosa*, Nuttall and Warburton, *Ticks* part 3, pp. 426-433, text-figs. 358-362.
1926. *Haemaphysalis bispinosa*, Fielding, *Commonwealth Austral. Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, pp. 60-62, text-fig. 23.
1927. *Haemaphysalis bispinosa*, Ogura and Takada, *Journ. College Agric. Hokkaido Imp. University* XVIII, pp. 204-205, pl. xiv, figs. 1-6.

Male.—The scutum is elongate-oval in shape and is slightly constricted opposite the spiracles. Its size varies from 1·5 × 1·1 mm. to 2·1 × 1·46 mm. The punctations are fine and irregularly scattered all over the scutum. The cervical grooves are represented by small, posteriorly convergent depressions which may in some cases be continued by shallow diverging areas. The emargination is moderately deep. The lateral grooves are shallow and commence opposite the second pair of legs and each includes the extreme festoon of the side. The festoons are twice as long as broad. The venter is pale yellow and is slightly hairy. The spiracle is sub-oval, longer than broad with its dorsal and ventral sides parallel. Tarsus IV tapers gradually and does not end in a spur. The pad attains two-thirds the length of the claws.



TEXT-FIG. 12.—*Haemaphysalis bispinosa* : (*a*) ♂, capitulum, dorsal aspect, × 121 ; (*b*) ♂, capitulum, ventral aspect, × 121 ; (*c*) ♀, ventral view of the right digit, × 293.

The capitulum is nearly as broad as long ; its length varies from 0·35 mm. to 0·4 mm. The base is twice as broad as long. The palps are half as broad as long, with articles II and III sub-equal. Article I is distinctly large, being visible both dorsally and ventrally, and bears one simple hair on the infra-internal margin. Article II has a dorsal ridge running round the external side and continued by a ventral ridge. The lateral salience lies in the middle of its length but is not very prominent. There are usually two to three slightly feathery hairs on the supra-internal margin and five large feathery hairs on the infra-internal margin. Article III is bluntly conical and bears a prominent dorsal retroverted spur in the mid-dorsal line and a similar but larger ventral spur : a tendency towards a decrease in size of the dorsal spur and the propor-

tionate increase of the ventral retroverted spur has been observed by me. In nearly every specimen that I have examined the hypostome has 4|4 rows of teeth with about nine teeth in each row ; an additional internal row of fewer teeth may be present on each half. The external cheliceral article possesses four cusps, the three distal being small and one of them sub-ventral in position. There is a serrate hair internal to the internal article of the digit.

Female.—The unfed female measures 2·25 × 1·7 mm. and is elongate-oval in shape but when replete measures 7·0 × 4·0 mm. The scutum is sub-cordiform. The punctations are a little larger than those of the male, but are sparsely scattered except on the lateral fields, where they are comparatively numerous. The marginal grooves commence opposite the second pair of legs and each includes two festoons of the side. There are unequal punctations all over the general body. The spiracle is as broad as long.

The capitulum is comparatively strong and is 0·44 mm. in length. The base is three times as broad as long. The porose areas are oval, and the interval between them is equal to twice their shortest diameter. The lateral saliences of the palps are more pronounced and pointed than those in the male. The external cheliceral article has five cusps, the three distal of which are small and one of them is sub-ventral in position. The dorsal process is crescent-shaped with the dorsal limb the larger.

Nymph.—The scutum is sub-pentagonal in shape with the posterior angle broadly rounded. It is broader than long and the surface has a granulated appearance. The following are the measurements [1] of the scutum of the nymphs from different places.

		Length	Breadth
Reg. No. $\frac{2382}{17}$ ..	Kierpur, Purneah District ..	0·39 mm.	0·48 mm.
Reg. No. $\frac{2380}{17}$ ..		0·39 mm.	0·52 mm.
Reg. No. $\frac{9011}{H2}$ ..	Nagpur, C. P. ..	0·43 mm.	0·48 mm.

The pad attains about half the length of the claws.

The capitulum is longer than broad and is 0·18 mm. in length. The cornua are poorly developed. The first article is fused with the second and the latter possesses two feathery hairs on the infra-internal margin and one simple hair on the supra-internal margin. The hypostome is armed with 3|3 rows of teeth with about six teeth in each row ; their number is fewer in the innermost row.

Distribution and hosts.—The species has a very wide range of distribution. It has been recorded from Primorsk in E. Siberia ?, Japan, China, Borneo, Sumatra (Nieschulz, 1924), the Federated Malay States, Burma, the Andaman Islands, India, Ceylon, New Zealand (Myers and Atkinson, 1924), Australia, Tasmania (Nicholls, 1922) and British East

[1] Nuttall and Warburton (*loc. cit.* p. 430) give 0·2 × 0·2 mm. as the size of the scutum of the nymph. This is, I think, a misprint. According to their measurements the scutum of the larva is larger than that of the nymph which is hardly likely. The scale of their diagram shows that the size of the nymphal scutum is at least twice as great as is given in their description.

Africa. It is found almost over the whole of this country and is very common in Burma, Assam, Bengal, Bihar and Orissa, the Central Provinces, Madras and Bombay Presidencies, but is rare in the United Provinces and the Punjab.

The following new records may be specially noted :—

Upper Burma :—Kamaing in the Myitkyina District (♂ ♀s, off cow, ♂ ♀, off dog and ♂s ♀s Os, off goat).

Lower Burma :—Insein (♂ ♀ Os, off bullock).

Assam Province :—Tezpur in the Darrang District (♂s ♀s, off horse). Nazira (♂s ♀ O, off dog, C. S. T. M. Coll.), Kamrup (♂s ♀s O, off pony and ♂s ♀s Os *Ls*, off bullock) and Gauhati (several lots containing ♂s ♀s Os, off horse, goat, dog, cow, buffalo, cat and sheep), all the three places in the Kamrup District. Nowgong (♂, off dog, C. S. T. M. Coll.) and Nagabera (3 lots of ♂s ♀s, off tiger), both in the Goalpara District. Kohima in the Naga Hills District (♂, off dog). Mayanaghor Tea Estate in the Cachar District (♀, off cow). Kaulaura in the Sylhet District (♂s, off Indian bison).

Bengal Presidency :—Berhampur in the Murshidabad District [1] (♂, off dog.). Paksey in the Pabna District (♀, on grass, ♂s ♀s, off dog and ♂, off cow). Naihati (♀, off tiger, C. S. T. M. Coll.), Calcutta (♂s ♀s Os *Ls*, host unknown, C. S. T. M. Coll., ♀, off dog C. S. T. M. coll. and ♀, off cow.) and Barackpore (♀s, off dog, C. S. T. M. Coll.), all in the Twenty-four Parganas District. Darghar in the Hooghly District (♀, off dog, C. S. T. M. Coll.). Kaptai in the Chittagong Hill Tracts District (♂s ♀s Os, off barking deer and ♀s, off dog).

Bihar and Orissa Province :—Katihar (♂s ♀s, off horse), Kierpur (♀s, found on grass and ♂s ♀s Os, off dog) and Bakuntari Araria (♂s, off horse), all in the Purnea District. Nawada in the Gaya District (♂s ♀s, off bullock). Pakaur in the Sonthal Parganas District (♂s ♀s Os, off cattle). Sasaram in the Shahabad District (♀s, off pony). Chatra (♀s, off cow, ♀, off buffalo, ♀s, off dog and ♂, off tiger) and Ramgah (♀, off cow), both in the Hazaribagh District. Gumla (♀, off cow) and Simdega (♀s, off cow), both in the Ranchi District. Porahat in the Singhbhum District (♀s, off dog). Bargarh in the Sambalpur District (♀, off bullock). Jonda Village (♀s, off bullock) and Phulbani (♀s, off cattle, ♂s ♀s Os, off goat), both in the Angul District. Puri (♀s, off dog and ♀s, off cow).

Central Provinces :—Mehra Camp in the Saugor District (♂s ♀, off rabbit, C. S. T. M. Coll.). Seoni (♀s, off bullock). Bhandara (♂ ♀s, off goat). Dindori (♂s ♀s, off cow) and Mandla (♂s ♀s, off goat), both in the Mandla District. Nagpur (♂s ♀ O, off spotted deer in captivity). Umerkhed (♀, off buffalo) and Darwha (♂s ♀s, off goat), both in the Yeotmal District.

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[1] Not Berhampur in the Madras Presidency as is recorded by Nuttall and Warburton [see Nuttall and Warburton, *Ticks* part 3, p. 431 (1915)].

Madras Presidency :—Parvatipuram in the Vizagapatam District (♀, off bullock). Amalapuram (♂s ♀s, off bullock) and Ramachandrapuram (♂s ♀s, off cow), both in the Godavari District. Palakol in the Kistna District (♂s ♀s, off bullock, ♂s ♀s, off donkey and ♂s ♀s, off buffalo). Anantapur (♂ ♀, off dog). Pakkam (♂s ♀s Os, off bullock) and Cuddalore (♂s ♀s, off donkey, ♂s ♀s, off cow and calf, ♂s ♀s, off goat and ♂s ♀s, off pony), both in the S. Arcot District. Srivilliputtur in the Ramnad District (♀s, off bullock). Coorg (♀, off bullock, Pusa Coll. ♀, off horse, Pusa Coll. and ♀s, off sheep, Pusa Coll.).

Bombay Presidency :—Belgaum (♂s ♀s O, off cattle). Hubli (♀s, off cow) and Navalgund (♂s ♀s, off bullock) both in the Dharwar District. Mahad in the Kolaba District (♂s ♀s, off bullock). Jambusar in the Broach District (♀s, off bullock). Ahmedabad (♂s ♀s, off goat). Kumta in the N. Kanara District (♂s ♀s Os *Ls*, off cattle).

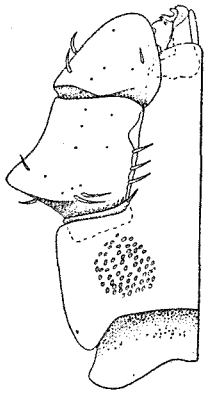
Punjab :—Kasauli in the Simla Hills (♀, off bullock, Kasauli coll.) Kotla, Kangra Valley, W. Himalayas (♂, under stones).

Andaman Islands :—Port Blair (♂s ♀s, host unknown, Pusa Coll.).

var. **intermedia** Warburton and Nuttall.

1915. *Haemaphysalis bispinosa* var. *intermedia*, Nuttall and Warburton, *Ticks* part 3, pp. 433-435, text-figs. 363, 364.

Male.—In general appearance var. *intermedia* resembles the typical form but differs from it as regards the capitulum. The capitulum has strong and sharply pointed cornua. Article II of the palp has a comparatively sharply-pointed lateral salience and also bears seven feathery hairs on the infra-internal margin instead of the usual five. There is a broad, ridge-like and obsolete retroverted spur on the dorsal



TEXT-FIG. 13.—*Haemaphysalis bispinosa* var. *intermedia* ♀: capitulum, dorsal aspect, × 87.

surface of article III. The size of the scutum varies from 1·4 × 1·1 mm. to 1·9 × 1·3 mm.

Female.—The capitulum is stronger than that of the male and is 0·45—0·5 mm. long. The external salience on article II is more sharply pointed than that of the male. There are nine feathery hairs on the infra-internal margin of article II. The third article is similar to that of the male.

I do not attach any importance to the retroverted point at the postero-internal angle of the third article which according to Nuttall and Warburton is the chief distinguishing feature of this variety from the *forma typica*. A similar point is not uncommon in other species of the genus *Haemaphysalis*. The poorly developed dorsal retroverted spur on the third article is enough to separate the variety from the typical form.

Distribution and hosts.—The variety is not so widely distributed as the *forma typica*. It has so far been recorded from Bihar and Orissa, the Central Provinces, Madras and Bombay Presidencies, Ceylon and once only from the United Provinces. It is usually parasitic on wild animals but in a very few cases it has also been recorded from domestic animals.

Bihar and Orissa:—Bankipur in the Patna Dist. (♀s, off dog). Hornia village, Simaria Police Station (♂s ♀s, off bear), Ramgarh (♀, off bullock) and Chatra (three lots of ♀s, off bullock and calf), all in the Hazaribagh District.

Central Provinces:—Nagpur (♀ O, off *Lepus simcoxi* Wroughton).

Haemaphysalis parva Neumann.

(Plate VIII, fig. 1.)

1915. *Haemaphysalis parva*, Nuttall and Warburton, *Ticks* part 3, pp. 435-437, text-figs. 365, 366.

Male.—It is smaller than that of *H. bispinosa*. The body is oval and in many specimens that I have examined is broadest in the middle. The cervical grooves are short and sub-parallel. The lateral grooves are poorly represented in most cases and each includes the extreme festoon of the side in all the specimens that I have examined. The spiracle is pear-shaped with its pointed end directed towards the postero-dorsal side. The pad reaches the tips of the claws. The following are the measurements of some males from Satpara in the Puri District, Bihar and Orissa.

	Length	Breadth
Reg. No. $\frac{2176}{17}$	1·3 mm.	1·0 mm.
Reg. No. $\frac{2160}{17}$	1·35 mm. 1·3 mm.	0·95 mm. 1·0 mm.
Reg. No. $\frac{2141}{17}$	1·44 mm. 1·4 mm.	1·05 mm. 1·0 mm.
Reg. No. $\frac{2140}{17}$	1·35 mm. 1·5 mm. 1·35 mm. 1·48 mm.	0·95 mm. 1·05 mm. 0·95 mm. 1·1 mm.

The capitulum is as broad as long, being 0·26—0·28 mm. in length. The lateral salience on article II is slightly more pronounced than in *H. bispinosa*. The second article has a slight ridge across the middle

of its three sides. It bears eight feathery hairs on the infra-internal margin and three on the supra-internal margin. Article III is broader than long and the posterior angle of the supra-internal margin projects inwards. This inwardly directed projection forms with article II a regular concavity along the inner margin. The backwardly directed dorsal spur on article III is smaller than in *H. bispinosa* and lies more towards the internal side. The ventral retroverted spur is very strong and reaches back to more than half the length of article II. The hypostome possesses 4|4 rows of teeth with about seven long narrow teeth in each row. The cheliceral digit is as in *H. bispinosa*, but does not bear any internal serrate hair.

Female.—The scutum is 0·73—0·8 × 0·68 mm. in size, being broadest about the middle. The punctations are slightly larger and deeper than those in the male, but are more sparsely scattered and are sub-equal. The cervical grooves are narrow, deep, sub-parallel and do not reach the posterior margin. The general body surface is unequally punctate. The spiracle is as in the male.

The capitulum is much stronger than that of the male. It is 0·4—0·43 mm. in length. The base is nearly three times as broad as long. The cornua are slightly shorter and blunter than those of the male. The porose areas are sub-circular with the space between them more than their diameter. The palps are nearly half as broad as long. The salience on article II is more pronounced than that in the male. It has usually four slightly feathery hairs on the supra-internal, and nine strongly feathery hairs on the infra-internal margin. The dorsal and ventral retroverted spurs are better developed than in the male. The cheliceral digits are as in the female of *H. bispinosa*.

Nymph.—The size of the scutum is 0·36×0·42 mm. The pad attains more than two-thirds the length of the claws. The spiracle is pear-shaped.

The capitulum is 0·18 mm. in length. The cornua and the backwardly directed ventral spur on article III are longer than those of the nymph of *H. bispinosa*. There are four feathery hairs on the infra-internal margin of article II. The hypostome has 2|2 rows of teeth with about six teeth in each row.

Distribution and hosts.—The species has been previously recorded from Ceylon and the Puri District in India. It usually attacks wild animals and consequently is of no economic importance. There are four lots in the Indian Museum collection, which were collected at Satpara in the Puri District. One of these (Reg. No. $\frac{2140}{17}$)[1] ♂s ♀s Os, off *Viverricula malaccensis*, in my opinion, has been wrongly identified and recorded by Nu'tall and Warburton as *H. bispinosa*. I have examined 2 ♀s (Muktesar Coll.), off cattle from Mysore, S. India.

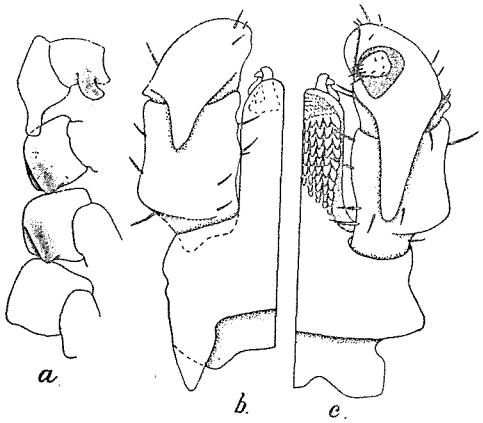
Haemaphysalis aculeata Lavarra.

1915. *Haemaphysalis aculeata*, Nuttall and Warburton, *Ticks* part 3, pp. 440-442, text-figs. 371, 372.

Male.—The size of a single male from Bangalore is 1·9 × 1·4 mm. The foveae are opposite coxa IV and are very wide apart, unlike those of

[1] Nuttall and Warburton, *Ticks* part 3, p. 431 (Cambridge, 1915).

the other species of the genus *Haemaphysalis*. The spur on coxa I is long and blunt and covers coxa II. According to Nuttall and Warburton coxae II-IV are unarmed but in the specimen which I have examined coxea II and III have each a short blunt spur near the middle of their length and the spur on coxa IV is absent. The ventral spur on trochanter I is not short and pointed, as stated by Nuttall and Warburton, but is fairly long and slightly curved. Tarsus IV is without any ventral spur and the pad almost reaches the tips of the claws.



TEXT-FIG. 14.—*Haemaphysalis aculeata* ♂: (*a*) coxal armature and ventral trochantal spur on trochanter I, × 34; (*b*) capitulum, dorsal aspect, × 80; (*c*) capitulum, ventral aspect, × 80.

The capitulum is 0·5 mm. in length. The base is twice as broad as long. The ventral ridge is almost straight. The palps are much longer than the proboscis and their tips are bent slightly inwards. They are two and a half times as long as broad. Article I is fused with article II. The latter has a slight ridge running round the dorsal, external and ventral surfaces of its proximal portion. It bears two or three simple hairs on its supra-internal and four slightly feathery hairs on its infra-internal margin. The ventral retroverted spur on article III covers more than two-thirds the length of article II and the dorsal spur of the same article covers a little less than half the length of article II. The hypostome in the specimen examined by me has 5|5 rows of very small teeth but in the specimens examined by Nuttall and Warburton have each 6|6 rows of teeth. The internal row has six narrow teeth and the others about ten teeth in each row. The external cheliceral article possesses a single cusp.

Female.—This sex is not represented in the collection at my disposal but there is a single female (type-specimen) in the collection of the Molteno Research Institute, Cambridge.

Distribution and hosts.—The species has, so far, been recorded off *Tragulus meminna* (Erxl.) (the mouse-deer) from the East Indies by Lavarra and off the same host from Ceylon by Warburton. I have examined a single male specimen from Bangalore in the Mysore State (off man, C. S. T. M. Coll.).

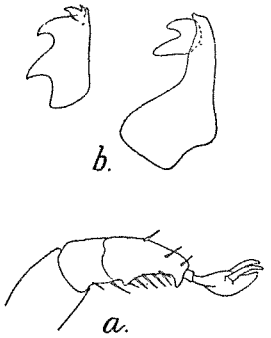
Haemaphysalis spinigera Neumann.

1910. *Haemaphysalis spinigera*, Neumann, *Ann. Sci. Nat.* (9) XII, pp. 174, 175.
1915. *Haemaphysalis spinigera*, Nuttall and Warburton, *Ticks* part 3, pp. 447-449, text-figs. 380-383.
1926. *Haemaphysalis spinigera*, Fielding, *Commonwealth Austral. Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, pp. 66-67.

Male.—The body is oval, with the lateral sides sub-parallel in the greater part of the posterior half and converging in the anterior half. It is broadest in front of the spiracle. The following are the measurements of the males from different localities:

		Length	Breadth
Reg. No. $\frac{2282}{17}$ .. Barkul	2·3 mm.	1·66 mm.
	2·4 mm.	1·71 mm.
	2·2 mm.	1·54 mm.
Reg. No. $\frac{2174}{17}$ .. Cochin	2·2 mm.	1·5 mm.
Coorg	2·1 mm.	1·5 mm.

The punctations are fine, equal, deep and numerous. The cervical grooves are deep anteriorly, shallow and divergent posteriorly. The lateral grooves which begin at the level of coxa II are narrow anteriorly, broad and shallow posteriorly, and each includes the extreme festoon of the side in the specimens which I have examined, but in specimens examined by Nuttall and Warburton they do not include any festoons. The festoons are half as broad as long and the separating grooves are deep. There are ventral spurs on all the trochanters. Tarsus IV tapers gradually to a ventral spur which is preceded by a similar but smaller ventral spur situated near the proximal end of the distal portion. The pad reaches almost to the tips of the claws.



TEXT-FIG. 15.—*Haemaphysalis spinigera*: (*a*) ♂, tarsus IV, × 45; (*b*) ♀, ventral view of the right digit, × 266.

The capitulum is broader than long, its length being 0·4 mm. The base is three times as broad as long. The cornua are strong and sharply pointed. The palps are nearly as broad as long with markedly unequal lateral saliences on articles II and III. The greater part of article I is visible ventrally. Article II is about twice as long as article III when viewed from the dorsal side. Its lateral salience possesses a very long backwardly directed ventral spur near its external side. This article bears two or three simple hairs on its supra-internal margin and

five or six slightly feathery hairs on the infra-internal margin. Article III is twice as broad as long. The teeth of the hypostome are long and sharply pointed and are arranged in 5|5 rows.

Female.—One unfed female in the collection measures 2·04 × 1·45 mm. and the shape of the body resembles that of the male. The scutum is broadest in the middle and the punctations are fine and deep. The following are the measurements of the scutums of females from different places :

		Length	Breadth
Reg. No. $\frac{2282}{17}$ .. Barkul		0·92 mm.	0·9 mm.
		0·96 mm.	0·92 mm.
Coorg		1·1 mm.	1·04 mm.
		1·04 mm.	1·04 mm.

The cervical grooves are deep and sub-parallel but do not reach the posterior margin ; a slight dimple-like oval depression is found externally to each of them. The marginal grooves are narrow and each includes one or two festoons of the side. The dorsal grooves are broad and shallow. The whole abdomen is finely punctate. The spiracle is somewhat broader than in the male. The ventral trochantal spurs are obsolete. The genital aperture is narrow and is situated opposite coxa III. The tarsi are devoid of spurs.

The capitulum is 0·38 mm. in length and the base is comparatively broader. The cornua are shorter and more blunt than in the male. The porose areas are oval and the interval between them is more than their largest diameter. The external contour of the palp is not so broken as in the male. The ventral retroverted spur on article II is smaller than that in the male. The teeth of the hypostome are comparatively strong. The external cheliceral article has three cusps and, in addition, there are five minute teeth on the ventral surface of the distal cusp.

A replete female from Coorg measures 9·0 × 6·5 mm.

Distribution and hosts.—The species has so far been recorded from Ceylon, Southern India and Judea in Palestine. The following new records from Southern India and the Central Provinces show that the species is not very uncommon in these parts of India.

Orissa :—Barkul in the Puri District (♂s ♀s, from under stones and on bushes).

Central Provinces :—Seoni (♀, off bullock).

Madras Presidency :—Coorg (♂ ♀s, off buffalo, Pusa Coll.). Cochin State (♂, found in forest tramway, miles 10-14, alt. 300 ft.).

Bombay Presidency :—Kumta in the N. Kanara District (♂ ♀, off bullock).

Haemaphysalis leachi (Audouin).

1915. *Haemaphysalis leachi*, Nuttall and Warburton, *Ticks* part 3, pp. 460-476, text-figs. 398-407.
1916. *Haemaphysalis leachi*, Nuttall, *Bull. Entom. Research* VI, pp. 319, 343, 344.
1916. *Haemaphysalis leachi*, Paoli, *Redia* XI, pp. 293-295, text-fig. 5, pl. vi, fig. 33.
1926. *Haemaphysalis leachi*, Fielding, *Commonwealth Austral. Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, pp. 56-58, text-fig. 21.

Male.—The punctations are numerous, of medium size, unequal and confluent in certain areas of the scutum. The cervical grooves are

narrow, deep, long and extend up to the level of the third pair of legs. The following measurements show the variation in the size of three males from the collection before me.

		Length	Breadth
Reg. No. $\frac{1524}{17}$	.. Kodarma, Hazaribagh District	.. 2·05 mm.	1·0 mm.
Reg. No. $\frac{1797}{17}$	.. Jogidih, Hazaribagh District	.. 1·35 mm. 1·65 mm.	0·9 mm. 1·05 mm.

Coxa I is one and a half times as broad as long, while the others are nearly as broad as long. The pad attains more than two-thirds the length of the claws.

The capitulum is 0·36 mm. in length and the base is twice as broad as long. The dorsal ridge is straight with a slight posteriorly-directed convexity in the middle. The palps are as broad as long. Article I is invisible and is fused with article II which has a very strong lateral salience provided with a long ventral retroverted spur and a short dorsal retroverted spur : the distal portion of the supra-internal margin has a lobe-like prominence. Article II bears two simple hairs on the supra-internal margin behind the lobe and about four [1] slightly feathery ones on the infra-internal margin. Article III is one-half the length of article II. The external cheliceral article possesses four cusps, the three distal being very small, and one of them being sub-ventral in position.

Female.—The size of the scutum of the female in the collection is 0·83 × 0·71 mm. The punctations are fine and numerous. The cervical grooves are shallow, almost parallel and do not reach the posterior margin. The lateral grooves are very faintly indicated. The coxae are longer than those of the male, especially the second and the third. The spurs on the lateral salience of article II of the palp are less strong than in the male.

Distribution and hosts.—The species has a very wide distribution in Africa. It has also been recorded from New Zealand,[2] Australia and in Asia from Borneo, Java, Sumatra, the Federated Malay States, Burma and India. In India it has been reported from Burdwar in the Nepal Terai and Jogidih in the Hazaribagh District. The type form is less commonly found in India than its variety var. *indica* and it is of no economic importance in this country. I have seen ♀s, off leopard, from an unknown locality in Bihar and Orissa and ♂, off wolf, shot four miles west of Kodarma Station in the Hazaribagh District by Major O. A. Smith.

var. **indica** Warburton.

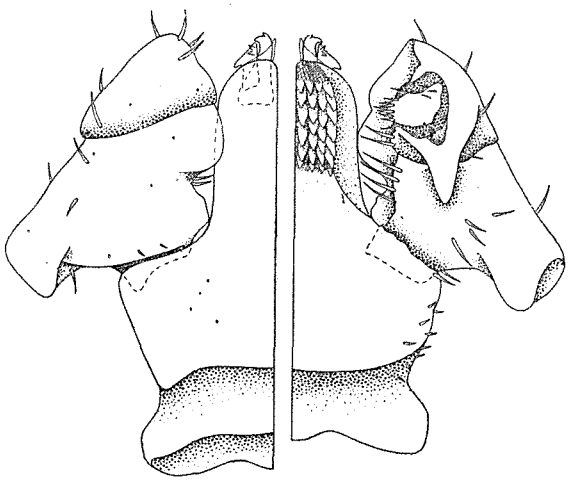
1910. *Haemaphysalis leachi* var. *indica*, Warburton, *Parasitology* III, p. 402.
1915. *Haemaphysalis leachi* var. *indica*, Nuttall and Warburton, *Ticks* part 3, pp. 467, 468, text-fig. 408.

Male.—It is generally smaller than the *forma typica* and its size is 1·5 × 0·88 to 1·6 × 1·0 mm. The punctations are fine, unequal, fewer

[1] Neumann in his figure of the capitulum of *H. leachi* has shown eight hairs on the infra-internal margin of palpal article II.

[2] According to Miller the species has been imported into New Zealand probably from India [see Miller, *New Zealand Journ. Agric.* XXIV, pp. 1-7 (1922)].

in number than in the *forma typica* and are sparsely scattered. The cervical grooves are represented by slightly converging depressions and they usually open into posterior shallow diverging areas which are, however, in some cases absent. Each lateral groove includes the extreme festoon of the side instead of the first two as in the *forma typica*. The dorsal trochantal spur is smaller and blunter than in the *forma typica*.



TEXT-FIG. 16.—*Haemaphysalis leachi* var. *indica* ♂: (*a*) capitulum, dorsal aspect, × 163; (*b*) capitulum, ventral aspect, × 163.

The capitulum is 0·28—0·32 mm. in length. The cornua are short and blunt. The lateral salience of palpal article II has two sub-equal spurs but these are much shorter and blunter than those in the typical form. The hypostome possesses 4|4 rows of teeth with about seven teeth in each row.

Female.—The unfed female measures 1·7 × 1·0 mm. The scutum is elongate-oval in shape, being broadest in the middle of its length. Its size is 0·85 × 0·75 mm. The cervical grooves are shallow and broad and extend up to more than half the length of the scutum. The lateral grooves are long and shallow. The punctations are fewer in number, larger than those in the typical form and comparatively numerous on the lateral fields. Each marginal groove includes three festoons of the side.

The capitulum is comparatively stronger than in the male and is 0·38—0·43 mm. in length. The porose areas are oval and the interval is greater than their largest diameter. The dorsal and ventral backwardly directed spurs on the lateral salience of palpal article II are obsolete. The external cheliceral article possesses five cusps, the three distal being small and one of them sub-ventral in position.

Nymph.—The unfed nymph is 0·98 × 0·66 mm. in size. The scutum is broader than long. The cervical grooves are sub-parallel, shallow, and do not reach the posterior margin. The spiracle is sub-circular. The following are the measurements in mm. of the scutum of nymphs

taken off *Canis aureus* Linn. by the late Dr. Annandale in the Indian Museum compound :—

Length				Breadth
0·45 mm.	..	..	..	.. 0·46 mm.
0·43 mm.	..	..	..	.. 0·45 mm.
0·36 mm.	..	..	..	.. 0·41 mm.
0·41 mm.	..	..	..	.. 0·46 mm.

The capitulum is 0·17—0·2 mm. in length and is like that of the female. The base is three times as broad as long and the cornua are slightly developed. The ventral cornua are present but are poorly developed. The palps are broader than long and articles II and III are fused, with their external margins forming a straight line. The backwardly directed dorsal spur on the lateral salience of article II is obsolete, while the ventral retroverted spur is long and conical. There are three slightly feathery hairs on the infra-internal margin of article II and one simple hair on its supra-internal margin. Article III has a poorly developed ventral retroverted spur. The hypostome is armed with 2|2 rows of about six teeth in each row.

Larva.—The scutum is broader than long and is 0·24 × 0·32 mm. in size. It is pentagonal in shape with the angles strongly rounded. The cervical grooves are normal but are slightly divergent posteriorly. The spur on coxa I is fairly well developed but those on the others are obsolete.

The capitulum is 0·92—0·1 mm. in length and is like that of the nymph. The cornua are absent. The ventral cornua are slightly developed as in the nymph. The hypostome has only 2|2 rows of five teeth in each row.

Nuttall is doubtful about the validity of this variety but a study of the available material has convinced me that it is quite distinct from the *forma typica.* The males of the two forms are very different though the females are not so easy to separate. The spurs on the lateral salience of the second palpal article of the female are quite distinct in the *forma typica* while they are obsolete in the female of the variety.

Distribution and hosts.—The variety has a fairly wide distribution in India and has been recorded from Bengal, Madras Presidency, the Central Provinces and Bombay Presidency. The new record of its occurrence in the United Provinces extends its area of distribution to include the whole of India. It generally attacks wild animals, but is occasionally found on dogs, cattle and goats. Round about Calcutta the goats are commonly attacked by *H. bispinosa* and this variety of *H. leachi.* Keeping in view the present data this variety does not appear to be of special economic importance.

I have examined specimens of this variety from the following localities :—

Bengal :—Calcutta, Indian Museum compound (3 lots of ♂s ♀s Os *I*s, off *Canis aureus* Linn.). Alampur village near Ra ganj in the Twenty-four Parganas District [♂s, off *Herpestes mungo* (Gmel.)].

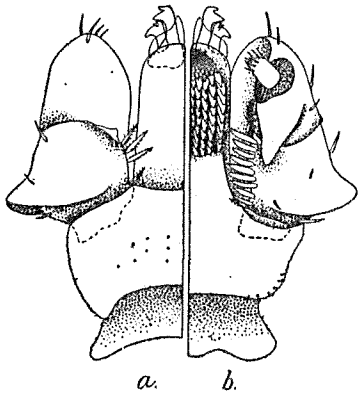
United Provinces :—Bhowali, alt. 6,000 ft. in the Naini-Tal District (♂ ♀, off cattle).

Orissa :—Satpara in the Puri District (♀s, off *Lepus* sp.).

Haemaphysalis wellingtoni Nuttall and Warburton.

1915. *Haemaphysalis wellingtoni,* Nuttall and Warburton, *Ticks* part 3, pp. 479-482, text-figs. 416-420.

Male.—The single male in the collection before me is 1·8 × 1·5 mm. in size. The punctations are slightly unequal; the larger ones are mostly found on the lateral fields of the pseudo-scutum, which is slightly more raised than the scutum. The non-punctate depression on either side of the centre, mentioned by Nuttall and Warburton, is not visible in this specimen. The festoons are longer than broad. The tarsi taper gradually and are without ventral spurs. The pad reaches the tips of the claws.



TEXT-FIG. 17.—*Haemaphysalis wellingtoni* ♂: (*a*) capitulum, dorsal aspect, × 95; (*b*) capitulum, ventral aspect, × 95.

The capitulum is broader than long and is 0·38 mm. in length. The base is sub-rectangular with convex lateral sides and is twice as broad as long. The cornua are short and blunt. The dorsal ridge is concave posteriorly and the ventral ridge is almost straight. The palps are one and a half times as long as broad and articles II and III are sub-equal. There is a dorsal ridge in the posterior half of the second article which runs round the lateral salience and is continued as a well raised ventral ridge. The second article bears about four slightly feathery hairs on the supra-internal margin and nine broad feathery hairs on the infra-internal margin. Article III when viewed from the dorsal aspect is nearly as broad as long with the lateral margins sub-parallel. The posterior angle on the supra-internal margin is produced into a blunt backwardly directed spur, and ventrally the article possesses a long spur that is conical and projects backward with a slight inclination towards the inner side. The hypostome according to Nuttall and Warburton has 4|4 rows, but in the specimen that I have examined it has 5|5 rows of teeth, the innermost row of each side having five or six teeth and the others about ten in each row. The external cheliceral article has four cusps, the distal three being small and one of these sub-ventral in position.

Female.—The scutum is 0·83× 0·87—1·1 × 1·0 mm. in size. The punctations are fine, deep and numerous. The cervical grooves extend over more than half the length of the scutum. The spiracle is pear-shaped.

The capitulum is comparatively large, its length being 0·56 mm. The base is three times as broad as long and is without cornua. The porose areas are oval, their long axes converging anteriorly ; the interval between them is equal to their long diameter. The palp is longer and the lateral salience more pronounced than in the male. The second article has a strong broad lobe-like ventral retroverted spur. The hypostome has 5|5 rows of about thirteen teeth in each row.

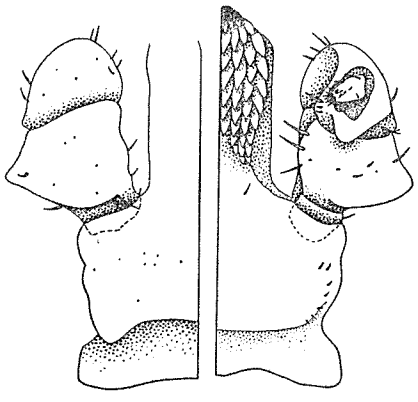
Distribution and hosts.—The species has, so far, been recorded from Borneo, Sumatra, the Federated Malay States, Siam and the Andamans ; in all these places it seems to be of some economic importance. I have seen specimens from the following localities :—

Assam :—Gauhati (♀, off a cock, C. S. T. M. Coll.).
Andaman Islands :—(♂ ♀s, host and locality unknown).

Haemaphysalis campanulata Warburton.

1915. *Haemaphysalis campanulata*, Nuttall and Warburton, *Ticks* part 3, pp. 491-493, text-figs. 431, 432.

Male.—The size of a mounted specimen is 2·0 × 1·0 mm. The emargination of the scutum is deep. The venter is hairy. There are eleven fairly well-developed scutes on the ventral side of the festoons. The anal ring is broad and well chitinised. The spiracle is trapezoidal in shape with a slight postero-dorsal extension. The leg segments are strong and the coxal armature is normal. Tarsus VI is slightly humped and is without ventral spurs. The pad attains more than half the length of the claws.



TEXT-FIG. 18.—*Haemaphysalis campanulata* ♂ : (*a*) capitulum, dorsal aspect, × 88 ; (*b*) capitulum, ventral aspect, × 88.

The capitulum is 0·43 mm. in length. The base is twice as broad as long and the cornua are strong and blunt. The ventral ridge is poorly

developed. The palps are one and a half times as long as broad. Article I is only visible from the ventral side. Article II is as broad as long and has a strong lateral salience about the middle of its length. It has a dorsal ridge which is continued round the lateral salience as a very strong ventral ridge. This article bears two or three simple hairs on the supra-internal margin and the same number of comparatively long simple hairs on the infra-internal margin. Article III is half as long as the second and is one and a half times as broad as long. It possesses only a single short blunt retroverted process, situated on its ventral aspect.

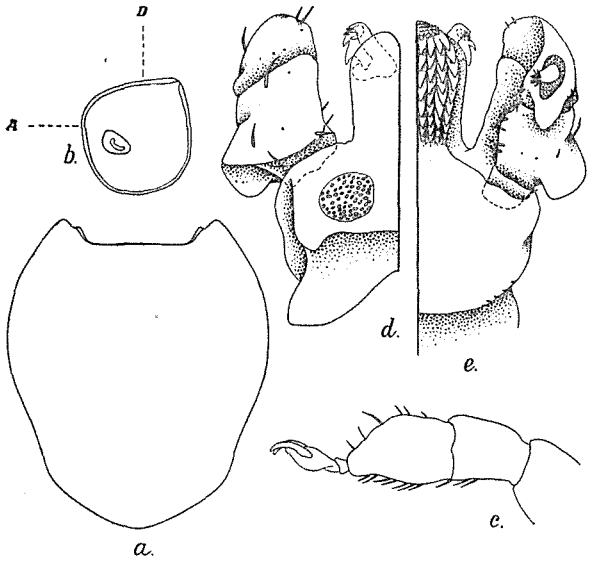
Female.—It is not represented in the collection before me; but is described by Nuttall and Warburton in their Monograph on this genus.

Distribution and hosts.—This species has previously been recorded from Japan, China, and from Satharangapara in the Travancore State, S. India. I have examined one male taken off a female wolf shot by Major A. O. Smith four miles west of Kodarma Station in the Hazaribagh District, Bihar and Orissa.

Haemaphysalis choprai, sp. nov.

Male.—Unknown.

Female.—The scutum is cordiform, being broadest in the anterior half and narrowing towards the posterior end. Its size is 1·2 × 1·1 mm. The emargination is moderate. The nature of the grooves and punctations could not be determined as the type-specimen is mounted on a slide. The spiracle is pear-shaped with both dorsal and anterior sides straight; its postero-dorsal extension is slight. The coxal



TEXT-FIG. 19.—*Haemaphysalis choprai* ♀: (*a*) scutum, × 34; (*b*) spiracle, × 74; (*c*) tarsus IV, × 55; (*d*) capitulum, dorsal aspect, × 53; (*e*) capitulum, ventral aspect, × 53.

armature is normal. Tarsus I is slightly humped and is without any ventral spur. The pseudo-articulation is situated about the middle

of the length of the fourth tarsus. The pad attains half the length of the claws.

The capitulum is 0·55 mm. in length and the base is three times as broad as long. The cornua are well developed and blunt. The porose areas are sub-circular in shape and the interval between them is equal to their diameter. The palps are one and a half times as long as broad. Article II is twice as broad as article III. The strong lateral salience in the middle of the second article bears ventrally a lobe-like retroverted process. Article II possesses two simple hairs on the supra-internal margin and about four on the infra-internal margin. Article III is one and a half times as broad as long and bears a long ventral retroverted process. The hypostome has 4|4 rows of teeth, with about nine teeth in each row. The external cheliceral article possesses five cusps; the distal three are very small and of these one is sub-ventral in position.

I have named this species after my friend and colleague Dr. B. N. Chopra, Assistant Superintendent, Zoological Survey of India. The type-specimen, a female, was taken off a female wolf shot by Major A. O. Smith four miles west of Kodarma Station, Hazaribagh District, Bihar and Orissa, is in the Indian Museum.

This species is closely related to *H. campanulata* from which it can be distinguished by the following features.

1. The cornua are better developed than in *H. campanulata.*
2. The porose areas in this species are separated by an interval equal to their diameter and not twice their diameter as in *H. campanulata.*
3. The lateral salience on article II of this species has a prominent lobe-like ventral retroverted process which is absent in *H. campanulata.*

Haemaphysalis cornigera Neumann.

1915. *Haemaphysalis cornigera,* Nuttall and Warburton, *Ticks* part 3, pp. 500-504, text-figs. 441-445.
1925. *Haemaphysalis cornigera,* Larrousse, *Ann. Parasitol. Hum. Comp.* III, pp. 301, 302, text-fig. 1.

Male.—The scutum is sayal-brown to verona-brown in colour; the separating grooves of the festoons and the posterior portion of the margin of the scutum are of a deep brown colour. The punctations are fine, numerous and close-set; those on the lateral fields are similarly arranged but slightly larger. The pseudo-scutum mentioned by Nuttall and Warburton in their description is not present in all the specimens that I have examined. The cervical grooves are represented anteriorly by short, deep and parallel depressions but posteriorly they are superficial, ill-defined and divergent. There are two irregular depressions in the centre of the scutum. The lateral grooves are short and in most cases they are superficial and ill-defined. The festoons are longer than broad. The spiracle in the specimens that I have examined is more sub-triangular than a short comma shape, with the macula near the anterior angle. The legs are strong with two rows of strong hairs on the ventral side of each leg. Coxae I-IV increase progressively in size from before backwards. Two spurs, well separated from each other, occur

on coxa IV ; in some specimens they are equally long, while in others the internal is longer than the external. Tarsus IV tapers gradually to a ventral spur which is preceded by a similar one near the proximal end of the distal portion. The pad reaches the tips of the claws.

The following are the measurements of males from Mainimukh :—

Length	Breadth
2·3 mm...	1·5 mm.
3·0 mm...	1·8 mm.
3·3 mm...	2·1 mm.
3·0 mm...	2·1 mm.
2·8 mm...	2·1 mm.

The capitulum is 0·45—0·53 mm. in length. The base is less than three times as broad as long. The palp is as broad as long. Article I is fused with article II and bears a single simple hair on its infra-internal margin. Article II is almost twice as long as article III and bears two simple hairs on the supra-internal and five simple hairs on the infra-internal margin. The lateral salience on article II bears a short, blunt and sub-triangular retroverted process on its ventral side. Article III is sub-triangular in outline and has three processes ; the dorsal one is short and broadly ridge-like, the external one is the longest and is directed slightly backwards, while the ventral one is of moderate size. The hypostome has 4|4 to 5|5 rows with usually ten teeth in each row. The external cheliceral article has five cusps. The distal three are very small and one of them is sub-ventral in position ; the two proximal ones are large and widely separated.

Female.—The unfed female is 2·6 × 1·6 mm. in size. The scutum is generally broader than long. The cervical grooves are sub-parallel and do not reach the posterior margin of the scutum. The punctations are deep, numerous, close-set and uniformly scattered all over the scutum. The marginal groove encloses the extreme festoon of the side. The spiracle is pear-shaped with the macula about the centre. The genital aperture is between the third pair of coxae. Tarsus IV has no ventral spurs.

The following are the measurements of the scutum of females from Mainimukh :—

Length	Breadth
1·3 mm...	1·4 mm.
1·0 mm...	1·1 mm.
1·1 mm...	1·3 mm.
1·3 mm. ..	1·4 mm.

The capitulum is 0·58 mm. in length. The base is three times as broad as long with short blunt cornua. The porose areas are sub-circular and the interval between them is equal to their diameter. The ventral retroverted process on the lateral salience of article II is obsolete. Article II has five feathery hairs on its infra-internal margin. Of the three processes on article III the external is obsolete and the ventral is much longer than that in the male. The lateral contour of article II is not continuous with that of article III. The hypostome has 4|4 rows with twelve comparatively stronger teeth in each row. The

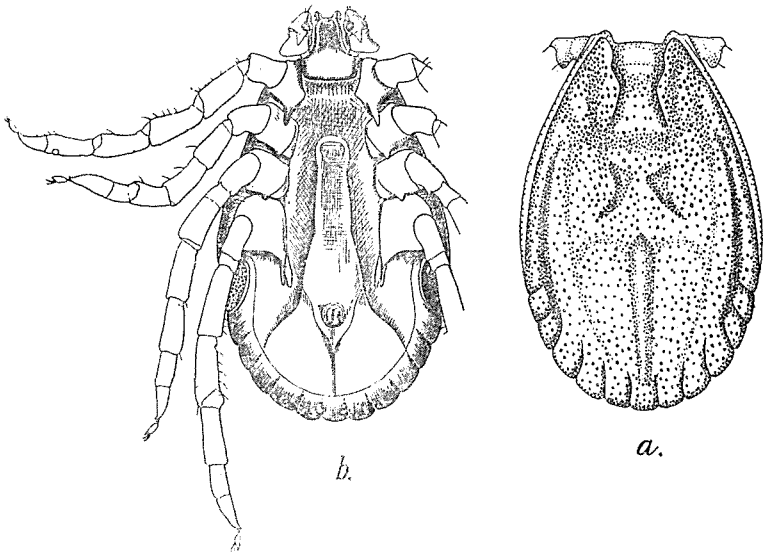
external cheliceral article bears five cusps of which the distalmost is the smallest and sub-ventral in position and the others increase in size progressively towards the proximal end.

Distribution and hosts.—This species has, so far, been recorded from Borneo, Java, Sumatra, the Federated Malay States, Annam and Judea in Palestine. Its record from Southern India is rather doubtful as the only female example found on deer at Satharangapara, Travancore, may have belonged to var. *anomala* Warburton. The females of the *forma typica* and var *anomala* are very similar and rather difficult to distinguish. I have determined several ♂s ♀s, off Sambhar deer shot by Mr. Mushtaq Ahmed at Mainimukh and ♂s ♀s, off dog from Kaptai, both in the Chittagong Hill Tracts District, E. Bengal and ♂s ♀s (Muktesar coll.) off Sambhar deer from Kochugaon in the Goalpara District, Assam.

var. **anomala** Warburton.

(Plate VIII, fig. 2).

1915. *Haemaphysalis cornigera* var. *anomala*, Nuttall and Warburton, *Ticks* part 3, pp. 504, 505, text-fig. 446.

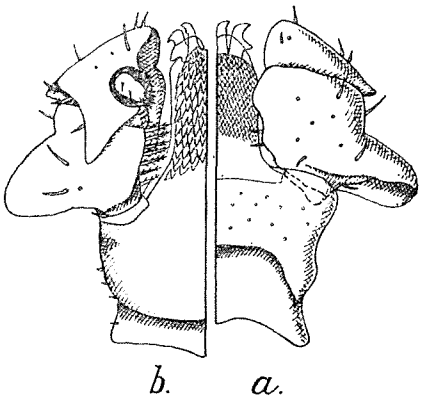


TEXT-FIG. 20.—*Haemaphysalis cornigera* var. *anomala* ♂ : (*a*) scutum, × 20 ; (*b*) venter, × 20.

Male.—The male of this variety is comparatively smaller in size than that of the *forma typica*. The pseudo-scutum is absent. The punctations are numerous, fine and deep, leaving a longitudinal median unpunctate island in the posterior half. The cervical grooves are as in the typical form but are better indicated. The lateral grooves are long and well defined and are narrow anteriorly, but are broad and shallow posteriorly. Each starts opposite leg III and includes the two extreme festoons of the side. The spiracle is sub-rectangular in shape with a

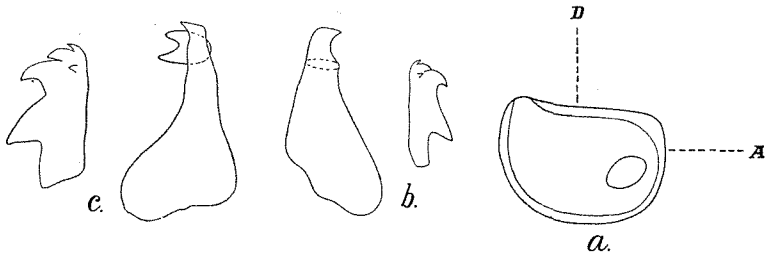
slight postero-dorsal extension. Coxa IV bears two long, equal and closely placed spurs. The pad attains two-thirds the length of the claws. The size of the five males in the Indian Museum Collection is as follows :—

			Length	Breadth
Reg. No. $\frac{2048}{17}$	.. (type-specimen)	Kodarma	.. 2·5 mm.	1·65 mm.
Reg. No. $\frac{8954}{H2}$	.. •	Kodarma	.. 2·6 mm.	1·4 mm.
Reg. No. $\frac{9993}{17}$		Ramgarh	.. 2·4 mm.	1·4 mm.
			2·5 mm.	1·4 mm.
			2·3 mm.	1·4 mm.



TEXT-FIG. 21.—*Haemaphysalis cornigera* var. *anomala* ♂ : (*a*) capitulum, dorsal aspect × 72; (*b*) capitulum, ventral aspect, × 72.

The capitulum is 0·46 mm. in length. The cornua are strong and sharply pointed as in the typical form. The salience on article II is without ventral retroverted process ; the article itself usually possesses six feathery hairs on its infra-internal margin. Of the three processes on article III the dorsal is obsolete, the external is very short and the ventral is longer than in the typical form. The hypostome has 5|5 rows of teeth, with usually ten teeth in each row, otherwise the capitulum is as in the typical form.



TEXT-FIG. 22.—*Haemaphysalis cornigera* var. *anomala* : (*a*) ♂, spiracle, × 55 ; (*b*) ♂, ventral view of the left digit, × 210 ; (*c*) ♀, ventral view of the right digit, × 210.

Female.—The scutum is oval in shape and is generally longer than broad. Its size is 1·2 × 1·05 mm. The cervical grooves are deeper than in the typical form and extend to the posterior margin of the scu-

tum. The punctations are fine, superficial and sparsely scattered, and are distinctly fewer in number in the posterior portion of the median field. The spiracle is as in the male but is a little broader. The coxal armature is as in the female of the typical form.

The capitulum is 0·43 mm. in length. It is similar to that of the *forma typica*. Palpal article III is without any external salience and its lateral contour is continuous with that of article II.

Distribution and hosts.—Warburton's type-specimen, a single male (Reg. No. $\frac{2}{17}\frac{0}{4}\frac{4}{8}$), was taken off a wolf shot near Kodarma Station in the Hazaribagh District. I have examined a male and a female off a dog from the same locality. The type-specimens of the male and the female are in Indian Museum. I have also examined specimens from Ramgarh in the Hazaribagh District (♂s ♀s, off bullock and cow) and Porahat in the Singhbhum District (♀, off buffalo), both in Bihar.

Genus **Rhipicephalus** Koch.

1806. *Ixodes* (*en partim*), Latreille, *Genera Crustaceorum et Insectorum* I, pp. 155, 156.
1834. *Ixodes* (*en partim*), Dugès, *Ann. Sci. Nat.* (2) II, p. 33.
1844. *Ixodes* (*en partim*), Gervais : in Walckenaer's *Histoire Naturelle des Insectes, Aptères* III, pp. 234-236.
1844. *Rhipicephalus* (*en partim*), Koch, *Arch. Naturgesch.* X (Bd. 1), p. 238.
1847. *Rhipicephalus* (*en partim*), Koch, *Übersicht des Arachnidensystems* Heft. 4, p. 26 (Nürnberg).
1889. *Phauloixodes*, Berlese, *Acari Myriopoda et Scorpiones hucusque in Italia reperta* LV. Nos. 7, 8 (Padua).
1897. *Rhipicephalus* (*en partim*), Neumann, *Mém. Soc. Zool. France* X, pp. 384, 385.
1904. *Rhipicephalus* (*Eurhipicephalus*), Neumann, *Arch. Parasitol.* VIII, pp. 448, 449.
1911. *Rhipicephalus*, Neumann, *Das Tierreich* XXVI, p. 32.
1911. *Rhipicephalus*, Nuttall and Warburton, *Ticks* part 2, p. 122.
1913. *Rhipicephalus* (*Pterygodes*), Neumann, *Bull. Soc. Zool. France* XXXVIII, pp. 147-149.
1913. *Rhipicephalus*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 598 (Madras).

The genus is represented in India by two species, *viz.*, the genotype *R. sanguineus* (Latreille) and *R. haemaphysaloides* Supino. The two Indian species are of economic importance ; the first is the most common Indian dog-tick and the second attacks both wild and domestic animals. The range of variation in the form and structure of both species is very wide.

Key to the Indian species of *Rhipicephalus*.

MALES.

I. Adanal shields triangular with internal margin almost straight ; punctations comparatively numerous, unequal and irregularly arranged ; basis capituli three times as broad as long	*sanguineus.*
II. Adanal shields sickle-shaped with external and posterior margins forming a regular curve ; punctations comparatively less numerous, strongly unequal, larger ones few in number and regularly arranged, finer ones numerous, very minute and hardly visible ; basis capituli twice as broad as long	*haemaphysaloides.*

FEMALES.

I. Punctations numerous, close-set, irregularly arranged, unequal, larger ones not found in the posterior portion of the median field	*sanguineus.*
II. Punctations few, sparsely scattered, strongly unequal, larger ones arranged almost in longitudinal rows and found in the posterior portion of the median field, finer ones hardly visible	*haemaphysaloides.*

Rhipicephalus sanguineus (Latreille).

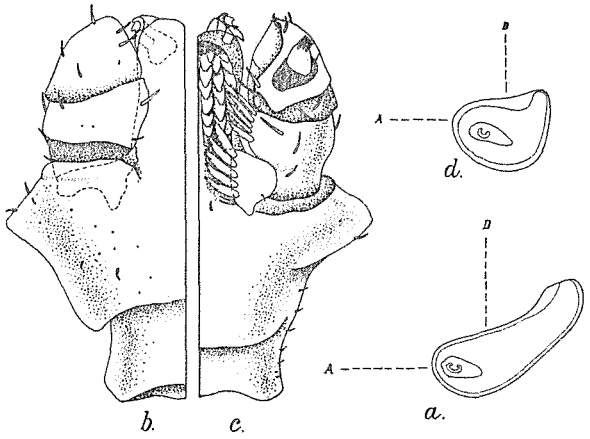
1806. *Ixodes sanguineus*, Latreille, *Genera Crustaceorum et Insectorum* I, p. 157.
1897. *Rhipicephalus sanguineus* (*en partim*), Neumann, *Mém. Soc. Zool. France* X, pp. 385-390, text-fig. 29.
1905. *Rhipicephalus sanguineus*, Dönitz, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1905, pp. 109-111.
1907. *Rhipicephalus sanguineus*, Christophers, *Sci. Mem. Off. Med. Sanit. Depts. India* (n. s.) No. 29, pp. 42-45.
1907. *Rhipicephalus sanguineus*, Warburton, *Bull. Imp. Dept. Agric. India* No. 6, p. 10, text-figs. 2-6, 8, 12.
1908. *Rhipicephalus sanguineus*, Samson, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1908, pp. 46-50.
1908. *Rhipicephalus sanguineus*, Bonnet, *Arch. Parasitol.* XII, pp. 262-264.
1908. *Rhipicephalus sanguineus*, Howard, *Ann. Transvaal Mus.* I, pp. 124-126, pl. viii, fig. e, pl. ix, fig. e, pl. x, figs. e, k.
1908. *Rhipicephalus texanus*, Banks, *U. S. Dept. Agric. Bur. Entom.* (Technical series) No. 15, pp. 34, 35, pl. v, figs. 1-4.
1909. *Rhipicephalus sanguineus*, Newstead, *Ann. Trop. Med. Parasitol.* III, pp. 437, 438.
1910. *Rhipicephalus breviceps*, Warburton, *Parasitology* III, pp. 398, 399, text-fig. 3.
1911.[1] *Rhipicephalus sanguineus sanguineus*, Neumann, *Das Tierreich* XXVI, pp. 35, 36, text-figs. 16, 17.
1912. *Rhipicephalus sanguineus*, Hooker, Bishopp and Wood, *Bull. U. S. Dept. Agric. Bur. Entom.* No. 106, pp. 102-111, pl. vi, figs. 10-17.
1913. *Rhipicephalus sanguineus*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 601, pl. lxxvii, figs. 1, 2 (Madras).
1914.[2] *Rhipicephalus sanguineus*, Cunliffe, *Parasitology* VI, pp. 372-378, 4 text-figs.
1915. *Rhipicephalus sanguineus*, Nuttall, *Parasitology* VII, pp. 448-456.
1916.[2] *Rhipicephalus sanguineus*, *id.*, *Bull. Entom. Research* VI, pp. 328-330, text-figs. 25-28.
1926. *Rhipicephalus sanguineus*, Fielding, *Commonwealth Australia Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, p. 70, text-fig. 29.

Male.—The body narrows gradually towards the anterior end, being broadest behind the spiracle especially in a fed male. Its size varies from $1{\cdot}8\times1{\cdot}4$ mm. to $3{\cdot}5\times2{\cdot}4$ mm. The scutum is either of Sanford's brown or bay colour. The eyes are flat. The cervical grooves are represented by short oval and slightly convergent pits. The lateral grooves are narrow and deep; they start a little behind the eyes and include one or two of the extreme festoons. The other dorsal furrows show considerable variation. Normally there is an elongated oval postero-median groove with a short oval depression on either side of it. In a few cases there are two similar but comparatively small oval depressions in front of the postero-lateral depressions. In rare cases they are replaced by long complete postero-lateral grooves. The punctations show a great variation in size, number and arrangement. The larger

[1] For further references see the synonymy of *R. sanguineus sanguineus* given by Neumann in this work.
[2] For illustrations of the structure see one of these two papers.

ones are few in number, but are more numerous in the anterior than in the posterior half. The emargination is deep. The festoons have no distinct scutes, but slight indications of these are discernible in the larger males. The caudal appendage, when present, is formed either by the median festoon alone or by it and the two festoons adjacent.

The venter is generally brown in colour but in the fed males is yellowish white. The internal margins of the adanal shields are slightly notched in the middle just opposite the anus. The accessory shields are poorly developed. In most cases they are represented by short posteriorly raised conical chitinous points, while in a few cases they are spindle-shaped. The ventral shields in the large specimens are considerably raised above the surface and the adanal shields are well separated from each other. The spiracle is long and comma-shaped with a narrow margin all round it except on the postero-dorsal side where the margin is broad. It is three times as long as broad. The tail portion is broad and is directed upwards and backwards. The coxae are longer than broad. Coxa I has two strongly unequal and closely placed strong spurs. Coxae II and III have each a short spur near the external angle and an obsolete broad ridge-like spur on the internal angle. Coxa IV possesses two short spurs ; one at the internal and the other at the external angle. The pad attains half the length of the claws.



TEXT-FIG. 23.—*Rhipicephalus sanguineus* : (*a*) ♂, spiracle, × 34 ; (*b*) ♂, capitulum, dorsal aspect, × 87 ; (*c*) ♂, capitulum, ventral aspect, × 87 ; (*d*) ♀, spiracle, × 34.

The entire capitulum is as broad as long. Its length varies from 0·43 mm. to 0·55 mm. The shape of the base is a broad hexagon when viewed from the dorsal aspect with lateral saliences in the anterior half ; it is about three times as broad as long. The posterior three sides of the base are each concave but the antero-lateral sides are almost straight. The cornua are short and blunt. The ventral ridge is somewhat convex posteriorly and the posterior neck-like portion of the basis capituli is very narrow. The palps are twice as long as broad with articles II and III sub-equal ; each has a slight longitudinal depression on the dorsal side. Article I is fully fused with article II on the ventral aspect but is distinctly separate from it on the dorsal side. On the dorsal

side the antero-internal angle of article I is prolonged into a projection ; ventrally it bears a plate carrying five to seven strong feathery hairs and one or two simple hairs. Article II is slightly narrow towards the proximal end and usually bears five feathery hairs on the infra-internal margin ; there are in addition two to four simple hairs on the supra-internal margin. Article III is slightly broader than long and the extreme tip is bluntly rounded : it bears a short ventral retroverted prominence. The hypostome has 3|3 rows of six to eight teeth.

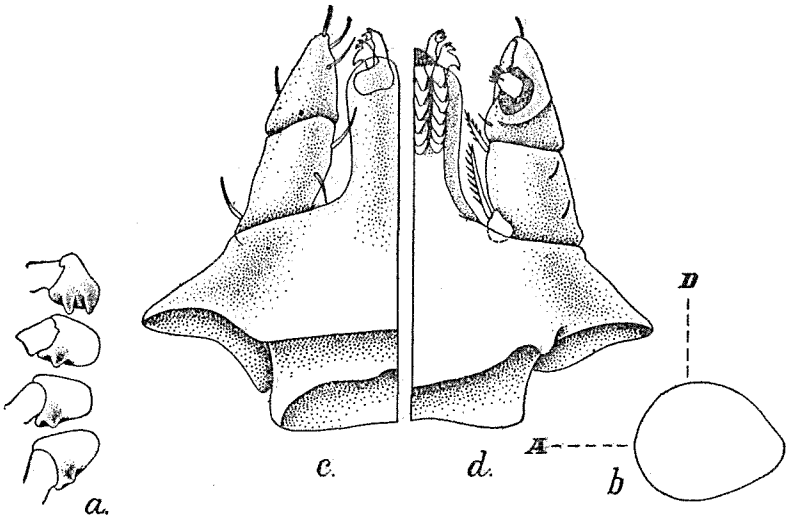
Female.—In the unfed female the body is an elongated oval, gradually narrowing towards the anterior end. The size of the unfed female varies from $2{\cdot}2\times1{\cdot}4$ mm. to $2{\cdot}7\times1{\cdot}6$ mm. The scutum is sub-hexagonal with slightly sinuous borders. It is slightly longer than broad and the size varies from $1{\cdot}1\times1{\cdot}0$ mm. to $1{\cdot}5\times1{\cdot}25$ mm. The emargination is deep. The cervical grooves at first approach each other, they then become divergent and finally reach the posterior margin of the scutum. The lateral grooves are mostly formed by the fusion of large punctations and with the cervical grooves enclose deep and punctate cervical fields. The punctations, as in the male, show great variation in size, number and arrangement. The larger ones are few in number and are usually not found in the posterior portion of the median field. In many specimens the punctations tend to be sub-equal. The marginal groove includes two extreme festoons of the side. The spiracle is sub-triangular with a well pronounced postero-dorsal angle. It is longer than broad. The coxal armature is similar to that in the male, but the internal spurs on coxae II-IV are obsolete.

The capitulum is stronger than that in the male. Its length varies from 0·52 mm. to 0·65 mm. The base is broader than in the male and the lateral saliences are situated at about the middle of its length. The porose areas are circular with the interval between them equal to the diameter. The hypostome has 3|3 rows of teeth with nine or ten teeth in each row. The teeth are stronger than those of the male.

Nymph.—The scutum is an elongated pentagon in shape ; the postero-lateral sides are short and meet each other in an almost rounded angle. The antero-lateral sides are long and converge anteriorly. The eyes are flat. The size of the scutum varies from $0{\cdot}48\times0{\cdot}48$ mm. to $0{\cdot}52\times0{\cdot}5$ mm. The emargination is moderate and the outer articulating processes of the scapulae are bluntly pointed. The cervical grooves are narrow, deep and convergent anteriorly but are broad, shallow and divergent posteriorly ; they reach the posterior margin of the scutum. The sexual depression is opposite coxa III especially in the unfed nymphs. The spiracle is oval in shape with a slight postero-dorsal extension and has practically no macula. Coxa I has two well-separated spurs, the external being slightly longer and narrower than the internal. Each of the other coxae has a single spur situated near the external angle and these gradually diminish in size from coxa II to coxa VI. The tarsi are without spurs and their distal portions taper towards the free end from the middle of their length.

The capitulum of the nymph differs considerably in its general outline from that of the adult. It is broader than long and the length varies from 0·2 to 0·25 mm. The base is four times as broad as long, with very

strong lateral saliences in the middle of its length. The dorsal ridge is straight and is without any cornua. The ventral ridge is convex posteriorly and has strongly developed ventral cornua. The palps are three



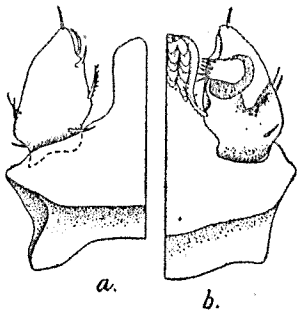
TEXT-FIG. 24.—*Rhipicephalus sanguineus* nymph : (*a*) coxal armature, × 47 ; (*b*) spiracle, × 200 ; (*c*) capitulum, dorsal aspect, × 200 ; (*d*) capitulum, ventral aspect, ×200.

times as long as broad with articles II and III sub-equal. Article I is entirely fused with the second and exhibits a slight indication of the ventral plate with a single long feathery hair. Article II is of uniform breadth throughout, and has a long feathery hair on its infra-internal and two simple hairs on the supra-internal margin. Article III narrows gradually towards the distal end and is provided with a slight ventral ridge posterior to the depression for the fourth article. The hypostome has 2|2 rows of teeth with seven to nine teeth in each row. The cheliceral digit resembles that of the female.

Larva.—The unfed larva is elongate-oval in shape, being broadest behind the last pair of legs and narrowing towards the anterior end. The size is 0·6×0·43 mm. The scutum is trapezoidal in shape, the posterior side being the longest and bent in the middle to form a convex curve. Its size is 0·22×0·35 mm. ; it is thus broader than long. It is brown in colour. The cervical grooves are at first convergent, they then diverge and finally reach the posterior margin. The eyes are large and flat. The festoons are separated by well-developed grooves. Coxa I has a short blunt spur on the internal angle and each of the other coxae has a short obsolete spur in the middle. Tarsus III narrows towards the distal end and is without a spur. The pad attains one-third the length of the claws.

The capitulum of the larva resembles that of the nymph more than that of the adult. It is 0·11 mm. in length. The base is an elongated hexagon with the lateral saliences well pronounced and sharply pointed. It is four times as broad as long. The cornua are absent. The ventral ridge is not prominent and is without ventral cornua. The three proxi-

mal articles of the palp are fused. The palps are conical in shape and are twice as long as broad with a slight rounded lateral salience on the part



TEXT-FIG. 25.—*Rhipicephalus sanguineus*, larva : (*a*) capitulum, dorsal aspect, × 208, (*b*) capitulum, ventral aspect, × 208.

which corresponds to article II, which bears one feathery and one simple hair on the supra-internal and one feathery hair on the infra-internal margin. Article III is conical and has a ventral retroverted spur. The hypostome has 2|2 rows of teeth with about six teeth in each row.

Warburton described and figured *R. breviceps* from a single female specimen obtained from *Erinaceus collaris* Gray and Hardwicke in Sindh ; I am of opinion that his species is only based on a somewhat abnormal specimen of *R. sanguineus* and should be relegated to its synonymy.

Distribution and hosts.—The species is the most widely distributed of all the Ixodid ticks. It has been found in almost all countries lying between 40° N. and 40°S. Its original home is in my opinion the Mediterranean sub-region and from here it has spread to other countries. Its chief host is the dog and it is this animal that is responsible for its wide distribution. In Asia it has been recorded from Eastern China, Philippines, Annam (Larrousse, 1925), Java, Sumatra, India, Ceylon, Persia, Arabia and Anatolia (Vogel, 1927). It is also found in Australia. In Africa it has been recorded from Seychelles (Warburton, 1912), Mauritius (De Charmoy, 1914), Madagascar, Somaliland, Abyssinia, Zanzibar, Tanganyika territory, Portuguese East Africa, Egypt, Nubia, Sudan, Cameroons, Congo, Transvaal, Natal, Cape Colony, S. W. Africa, Tunis, Algeria, Morocco (Lavier, 1923), Nigeria (Simpson, 1912, a, b), Togoland, Sierra Leone (Simpson, 1913) and Senegal, in Europe from Cacausia (Yakimoff, Kohl-Yakimoff, 1911), the Mitylene Island (Senevet, 1920), Rumania, Turkey, Greece, Italy, Sicily, Corsica, France and Portugal and in America from Texas, Mexico, Panama, the West Indies (Dominica, Antigua, Haiti, Jamaica, etc.), Colombia, Guiana and Brazil. It has also been reported from the Hawaiian Islands in the North Pacific Ocean.

In India, Burma and Ceylon it is found throughout the whole country, as in other countries it chiefly infests the dog but occasionally attacks the following animals : cattle, horse, donkey, goat, wild boar, bear, fox, *Erinaceus collaris* Gray and Hardwicke, *Erinaceus pictus* Stoliczka, *Erinaceus jerdoni* Anderson, *Erinaceus micropus* Blyth, *Felis marmorata* Martin, *Felis viverrina* Bennet and *Canis aureus* Linn.

Rhipicephalus haemaphysaloides Supino.

(Plate VIII, figs. 3, 4).

1897.[1] *Rhipicephalus haemaphysaloides ruber, Rhipicephalus haemaphysaloides niger,* Supino, *Atti. Soc. Veneto-Trent. Sci. Nat.* (2) III, p. 234.

1897. *Rhipicephalus paulopunctatus, Rhipicephalus haemaphysaloideo, Rhipicephalus ruber,* Neumann, *Mém. Soc. Zool. France* X, pp. 397, 398, 417, 418.

1902. *Rhipicephalus paulopunctatus, Rhipicephalus haemaphysaloides ruber,* Neumann, *Arch. Parasitol.* VI, pp. 121, 125, 126, text-fig. 6.

1904. *Rhipicephalus haemaphysaloides,* Neumann, *Arch. Parasitol.* VIII, p. 454.

1907.[2] *Rhipicephalus haemaphysaloides,* Warburton, *Bull. Imp. Dept, Agric. India* No. 6, p. 10, text-fig. 15.

1911. *Rhipicephalus haemaphysaloides haemaphysaloides, Rhipicephalus haemaphysaloides niger,* Neumann, *Das Tierreich* XXVI, pp. 41, 46, text-fig: 21.

1913. *Rhipicephalus haemaphysaloides,* Patton and Cragg, *A Textbook of Medical Entomology* pp. 598, 601, pl. lxxiii, fig. 9, pl. lxxvii, fig. 6 (Madras).

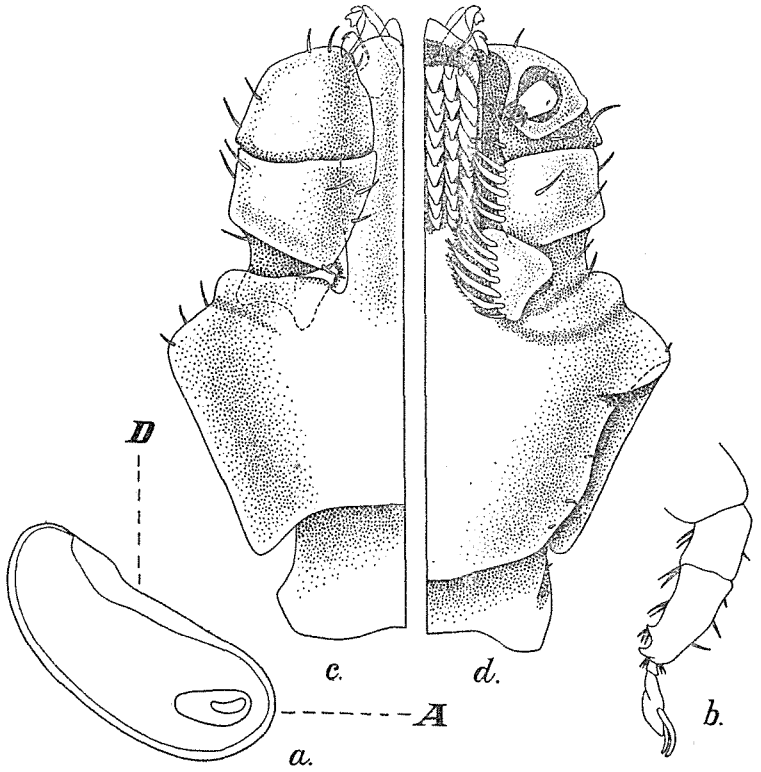
Male.—The body is elongate-oval in shape narrowing towards the anterior end and is broadest opposite the spiracle. Its size varies from $2{\cdot}2 \times 1{\cdot}4$ mm. to $3{\cdot}75 \times 2{\cdot}6$ mm. The scutum covers the whole of the dorsal surface and is Sanford's brown to warm blackish-brown in colour. The eyes are flat and large in size. The cervical grooves are represented by short converging pits which are continued posteriorly as superficial diverging areas which almost reach the posterior margin of the pseudo-scutum, this latter structure, however, is not generally well differentiated from the rest of the scutum in the specimens which I have examined. The lateral grooves commence a little behind the postero-lateral angles of the pseudo-scutum and include one or two extreme festoons. They are narrow, deep and enclose a few large punctations. The postero-median groove occupies the posterior one-third of the scutum and is broad posteriorly but narrows towards the anterior end. On either side of it lies an elongated oval pit that is continued posteriorly by the groove separating festoons III and IV. In some specimens two oval depressions are found in front of the postero-lateral grooves. The larger punctations are few, sparsely scattered and conspicuous. The finer punctations [3] are numerous and are generally so fine as to be hardly visible. There are eleven scutes which are as a rule well developed and conspicuous. The caudal appendage is generally absent but when present is formed by the protrusion of the median festoon. In a few males from Pashok (Darjeeling District) there are three protrusions, each arising from one of the median festoons, the central protrusion being the largest. The adanal shields are usually sickle-shaped but in certain cases they tend to approach a condition somewhat similar to that of *R. sanguineus* in which these structures are slightly notched (*vide supra* p. 276). The accessory shields are less chitinous and in the

[1] Females of *R. haemaphysaloides* Supino are sometimes of a black colour, hence I think *R. haemaphysaloides niger* Supino, a doubtful subspecies according to Neumann, may be a variation of *R. haemaphysaloides* and should not be considered worthy of subspecific rank.

[2] Text-fig. 15 is that of *R. haemaphysaloides* and not that of *Hyalomma aegyptium* (Linn.) as stated by Warburton.

[3] The finer punctations have never been mentioned by any previous worker. They are so fine that only after a careful examination one can see them. They are present in all the specimens that I have examined.

majority of cases are poorly developed, being represented by only short chitinous protrusions. The spiracle is comma-shaped but the part corresponding to the tail region of the comma is broad and short. It is about twice as long as broad. The coxal armature resembles that of *R. sanguineus*, but the spurs are better developed. The genital aperture lies opposite coxa II. Tarsus IV tapers gradually into two sub-equal ventral spurs, as in *Rhipicephalus sanguineus*. The pad attains half the length of the claws.



TEXT-FIG. 26—*Rhipicephalus haemaphysaloides* ♂: (*a*) spiracle, × 73; (*b*) tarsus IV, ×45; (*c*) capitulum, dorsal aspect, × 120; (*d*) capitulum, ventral aspect, ×120.

The entire capitulum is longer than broad and its length varies from 0·53 mm. to 0·66 mm. The base when viewed from the dorsal aspect is a broad hexagon and is twice as broad as long. It possesses short blunt lateral saliences situated somewhat anteriorly in position, *viz.*, in the anterior one-third. The cornua are stronger than those in *R. sanguineus*. The palps are much longer than broad with slight external saliences on articles II and III which are sub-equal. Article I is fused with article II ventrally but is distinctly separated from it on the dorsal side. It bears a ventral plate having six or seven feathery hairs and a single simple hair. Article II is strongly constricted in the proximal half and bears a ridge running round the middle of the dorsal, ventral and external surfaces thus making a lateral salience. It usually bears six feathery hairs on the infra-internal and four simple ones on its supra-

internal margin. Article III is broader than long and bears a retroverted spur-like ventral prominence. The hypostome has 3|3 rows of teeth with nine to ten teeth in each row. The external cheliceral article possesses two cusps.

Female.—The body of the unfed female is elongate-oval in shape and narrows towards the anterior end, being broadest in front of the spiracle. The smallest specimen in the collection from Kurseong (Darjeeling District) is 2·6×1·7 mm. in size. The scutum is oval with a sinuous border that tends to approximate to a hexagon and is longer than broad. Its size varies from 1·5×1·45 mm. to 1·9×1·7 mm. The cervical grooves are deep and convergent anteriorly but are shallow and divergent posteriorly, they generally reach the posterior margin of the scutum. The lateral grooves are formed by large punctations. The punctations are strongly unequal; the larger ones are few in number and tend to be arranged in longitudinal rows, while the finer punctations are numerous but generally so minute as to be hardly visible. The spiracle is subtriangular and almost as broad as long: it has a large macula. The coxal armature is as in *R. sanguineus*. The largest specimen in the collection, which is an almost replete female, is 12·0×9·0 mm. in size.

The capitulum is comparatively stronger than that in the male. Its length varies from 0·78 to 0·93 mm. The lateral saliences at the base are sharper, more pronounced and lie a little posterior to those in the male. The cornua are short and blunt. The porose areas are circular with the interval between them less than their diameter. The palps are twice as long as broad. The dorsal process is crescent-shaped. The hypostome has 3|3 rows of teeth with ten or eleven strong teeth in each row. The external cheliceral article bears three cusps.

Distribution and hosts.—This species attacks both wild and domestic animals and is, therefore, of economic importance. It has so far been recorded off *Bos taurus* Linn. from China, Borneo, Java, Sumatra, Burma and Ceylon by Neumann, off cattle and sheep from the Chin Hills in Burma, Moradabad in the United Provinces and off bear, dog and leopard from Ceylon by Warburton (1925). The following new records show that it is widely distributed throughout India.

Burma.—Mon Ton, alt. 4,200 ft. in the Mongmit State in the Ruby Mines Dist. of Upper Burma (♂ ♀, host unknown). Western slopes of Pegu Yomas, alt. 1,300 ft. in the Theyetmyo Dist. of Lower Burma (♂, host unknown).

Assam.—Nagabera in the Goalpara Dist. (♂s, off tiger).

Bengal Presidency.—Pashok [4 lots containing ♂s ♀, from unknown hosts, ♂s ♀, off *Nemorhaedus bubalinus* (Hodgson) and ♂s ♀s, off *Cervulus muntjac* (Zimm.)], Singla, alt. 1,500 ft. (♂s ♀s, host unknown), Sukna, alt. 1,000 ft. (♂s ♀s, host unknown), Abootia (♂, from jungle, C. S. T. M. Coll.) and Kurseong, alt. 5,000 ft. (♂s ♀s, off goat) all in the Darjeeling Dist. Basanti Forest Station in the Twenty-four Parganas Dist. (♂, host unknown).

Bihar and Orissa Provinces.—Siripur (♂, off jackal and ♂ ♀, off Bengal hare) and Usri Bazar (♀s, off fox, Pusa Coll. and ♂,

off jackal, Pusa Coll.), both in the Saran Dist. Bankipore in the Patna Dist. (♂s ♀s, off dog). Sasaram in the Shahabad Dist. (♀s, off leopard). Chatra (♀, off mare, ♂s ♀, off dog, ♂, off cow and ♂ ♀s, off bullock), Hornia village, Simaria Thana (♀, off bear), Ramgarh (♂s ♀s, off cow), Kodarma (♀, off wolf) and Barhi (♀, off *Sus cristatus* Wagner), all in the Hazaribagh Dist. Sahebganj in the Sonthal Parganas Dist. (♂ ♀, off goat). Larpur (♂s, host unknown). Purulia in the Manbhum Dist. (♀, off horse). Porahat in the Singhbhum Dist. (♀, off buffalo). Sambalpur Town (♀s, off buffalo). Angul Agricultural farm (♀, off buffalo) and Phulbani (♀, off cattle), all in the Angul Dist. Satpara in the Puri Dist. (♂s ♀, off *Felis viverrina* Bennet and ♂ ♀, off *Lepus* sp.).

United Provinces.—Bhowali, alt. 6,000 ft. (♂s ♀s, off sheep, ♂s ♀s, off cattle, ♂s ♀s, off dog, C. S. T. M. Coll. and ♀s, off man, C. S. T. M. Coll.), Malwa Tal, alt. 3,600 ft. [♂s ♀s, off *Cervulus muntjac* (Zimm.)], Muktesar (♂s ♀s, off Pine marten ? Muktesar Coll.), all in the Naini-Tal Dist. Babugarh in the Meerut Dist. (♂s ♀, off sheep, Muktesar Coll.).

Central Provinces.—Bilaspur Town (♀, off cow). Binjori in the Mandla Dist. (♂s ♀s, off buffalo). Bhandara Town (♀, off goat). Nagpur ♂s ♀, off *Lepus Simcoxi*). Shegaon in the Buldana Dist. (♀, off goat).

Madras Presidency.—Palakol in the Kistna Dist. (♂, off donkey). Cuddalor in the S. Arcot Dist. (♀, off donkey). Srivilliputur in the Ramnad Dist. (♂, off camel). Bangalore in the Mysore State (♀, host unknown). Parambukulam in the Cochin State [♂, off *Hemitragus hylocrius* (Ogilby)].

Bombay Presidency.—Ahmedabad (♂ ♀s, off goat). Belgaum (♂ ♀, off cattle). Kumta in the N. Kanara Dist. (♀, off bullock).

Punjab.—Kasauli in the Simla Hills, W. Himalayas (♂ ♀s, off leopard, Kasauli Coll.). Near Kareri Lake, alt. 10,000 ft., Kangra Valley, W. Himalayas (♂s, off sheep).

Genus **Boophilus** Curtice.

1821. *Ixodes* (*en partim*), Say, *Journ. Acad. Nat. Sci. Philadelphia* II, p. 75.
1844. *Rhipicephalus* (*en partim*), Koch, *Arch. Naturgesch.* X (Bd. 1), p. 238.
1891. *Boophilus*, Curtice, *Journ. Compar. Med. Veter. Arch.* XII, p. 313.
1897. *Rhipicephalus* (*en partim*), Neumann, *Mém. Soc. Zool. France* X, pp. 384, 385.
1904. *Rhipicephalus* (*Boophilus*), Neumann, *Arch. Parasitol.* VIII, pp. 448, 449, 450.
1905. *Boophilus*, Dönitz, *Sitzungsb. Ges. Naturf. Freunde Berlin* Jahrg. 1905, pp. 124, 125.
1907. *Margaropus* (*en partim*), Neumann, *Arch. Parasitol.* XI, pp. 223, 224.
1907. *Boophilus*, Warburton, *Journ. Econ. Biol.* II, p. 91.
1907. *Boophilus*, Dönitz, *Sitzungsb. Ges. Naturf. Freunde Berlin* Jahrg. 1907, pp. 187-193.
1908. *Margaropus* (*en partim*), Bonnet, *Arch. Parasitol.* XII, p. 264.
1911. *Margaropus* (*en partim*), Neumann, *Das Tierreich* XXVI, p. 47.
1911. *Boophilus*, Nuttall and Warburton, *Ticks* part 2, p. 124.
1913. *Margaropus* (*en partim*), Patton and Cragg, *A Textbook of Medical Entomology*, p. 606 (Madras).

The genus *Boophilus* was created in 1891 by Curtice to include *Ixodes bovis* Riley [1] but later Neumann (1897) united it with *Rhipicephalus* Koch. In 1904 the latter worker recognised *Boophilus* as a subgenus of *Rhipicephalus* Koch and in 1907 he concluded that *Rhipicephalus annulatus* (Say) with its varieties is distinct from the genus *Rhipicephalus* and placed it along with his new species *M. lounsburyi* under the genus *Margaropus* Karsch, with which he combined *Boophilus* Curtice. Stiles, Hassall, Lahille, Dönitz, Nuttall and Warburton, however, all recognise *Boophilus* as a genus distinct from *Margaropus*. The last two workers recognise three species in the genus *Boophilus* Curtice, *viz.*, *B. annulatus* (Say), B. *decoloratus* (Koch) and *B. australis* (Fuller) and two species in the genus *Margaropus* Karsch, *viz.*, *M. winthemi* Karsch and *M. lounsburyi* Neumman.

The species of the genus *Boophilus* are easily distinguished from those of the genus *Rhipicephalus* by the absence of festoons and in having an obsolete anal groove and rounded or oval spiracles in both sexes. In addition to these differentiating characters, the members of the genus *Boophilus* have no setiferous ventral plate on palpal article I, which itself is hardly visible, and in the male there is no post-genital strengthening plate.

In India the genus *Boophilus* is represented by *B. australis* and *B. annulatus* subsp. *calcaratus* (Birula): the former is one of the commonest Indian ticks but the latter is now being recorded for the first time from this area.

Key to the two Indian species of *Boophilus*.

Males.

I. Comparatively large species; caudal appendage present, adanal and accessory shields strongly chitinised; scutum more hairy	*australis.*
II. Comparatively small species; caudal appendage absent; adanal and accessory shields less strongly chitinised; scutum less hairy	*annulatus* subsp. *calcaratus.*

Females.

I. Posterior angle of the scutum broad; cornua comparatively large	*australis.*
II. Posterior angle of the scutum pointed; cornua comparatively small	*annulatus* subsp. *calcaratus.*

Boophilus australis (Fuller).

(Plate VIII, fig. 5).

1899. *Rhipicephalus australis*, Fuller, *Queensland Agric. Journ.* IV, p. 392, text-figs. 1, 3, 4.
1902. ? *Rhipicephalus annulatus*, Neumann, *Arch. Parasitol.* VI, p. 121.
1905. ? *Rhipicephalus annulatus*, Skinner, *British Med. Journ.* II, p. 624.
1907. *Rhipicephalus annulatus*, Christophers, *Sci. Mem. Off. Med. Sanit. Depts. India* (n. s.) No. 29, p. 38.

[1] *I. bovis* Riley is a synonym of *B. annulatus* (Say), the type-species of the genus *Boophilus* Curtice.

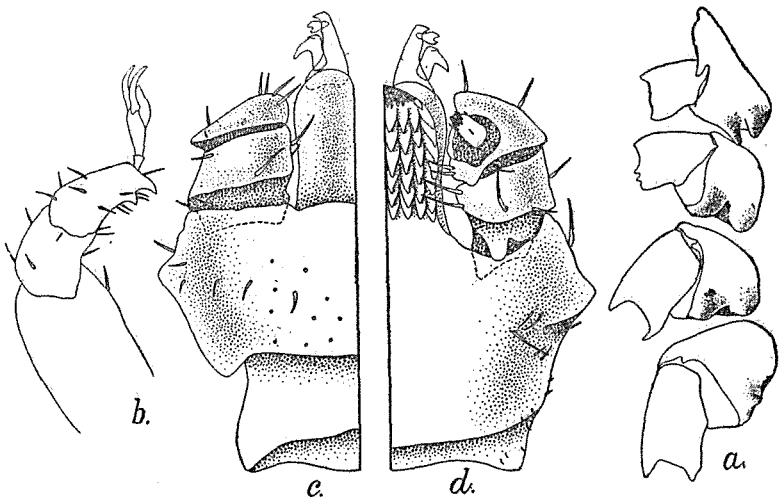
1907. *Boophilus australis*, Warburton, *Bull. Imp. Agric. Dept. India No. 6*, p. 9, text-figs. 7, 11, 13.
1908. *Margaropus annulatus* var. *australis*, Howard, *Ann. Transvaal Mus.* I, pp. 110, 111, pl. vi, figs. p-s.
1909. *Margaropus annulatus* var. *australis*, Newstead, *Ann. Trop. Med. Parasitol.* III, pp. 435-437.
1911.[1] *Margaropus annulatus australis*, Neumann, *Das Tierreich* XXVI, p. 48.
1912. *Margaropus annulatus* var. *australis*, Bishopp, Hooker, and Wood, *Bull. U. S. Dept. Agric. Bur. Entom.* No. 106, pp. 117-123.
1913. *Margaropus annulatus* var. *australis*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 607 (Madras).
1926. *Boophilus australis*, Fielding, *Commonwealth, Australia Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, pp. 71-74, text-fig. 30, pl. i, figs. 1, 2.

Male.—The body is oval and is broadest in front of the spiracle. The size varies from 1·5×1·0 mm. to 2·3×1·7 mm. In most cases there are lateral extensions of the body beyond the scutum. The scutum in colour is Sanford's brown or auburn, and is slightly constricted opposite the spiracle. It is hairy and the hairs are arranged in longitudinal bands, of which two are situated laterally, running along the lateral margins, and one median which is divided posteriorly into two by the postero-median groove. Larger specimens are generally less hairy. The emargination is deep and the scapula is divided by a notch into two processes, of which the external is the larger of the two. The cervical grooves are broad, shallow, divergent and reach the junction of the anterior and middle thirds of the scutum. Each cervical groove may in certain cases join with the postero-lateral groove of the same side. The postero-median groove occupies the posterior one-third of the scutum. It is narrow anteriorly, but widens posteriorly. The postero-lateral grooves are longer than the postero-median groove and are generally interrupted in their middle. Their anterior portions may be totally cut off when they appear as detached oval depressions. The punctations are fine and equal and are irregularly scattered. The eyes are flat. The caudal appendage shows a considerable range of variation as regards its size. The festoons are absent.

The venter is comparatively much lighter in colour and is hairy. The genital aperture is situated at the level of the antero-internal angles of the second pair of coxae. The adanal shields are sub-rectangular, narrowing towards the anterior end : they are four times as long as broad with their posterior sides slightly concave. Their postero-internal angles are pointed and the postero-external angles are almost rounded. The accessory shields are small and sub-triangular in shape, with the postero-internal angles pointed and the postero-external angles rounded. All four plates are hairy and punctate. In some of the larger specimens the posterior portions of the shields project beyond the body. The spiracle is sub-circular with a uniformly thick margin. The macula lies in the centre. The segments of the legs are strong and massive, especially those of the last two pairs. Coxa I is triangular in shape with its apex projecting towards the anterior end and is visible dorsally on the side of the basis capituli. There are two spurs on its posterior side, the external being long and narrow and the internal being short and broad. Coxae II and III have each two short blunt tuberosities,

[1] For further references see the synonymy of *M. annulatus australis* given by Neumann in the work cited.

the internal being almost obsolete. Coxa IV bears only the external spur which is excessively small. The tarsus is much narrower than the other segments of the leg. The pseudo-articulation of tarsus IV is in the middle of its length and the distal portion tapers gradually to a strong ventral spur which is preceded by a similar but smaller ventral spur. The pad attains less than half the length of the claws.



TEXT-FIG. 27.—*Boophilus australis* ♂ : (*a*) coxal armature, × 48 ; (*b*) tarsus IV, × 73 ; (*c*) capitulum, dorsal aspect, × 107 ; (*d*) capitulum, ventral aspect, × 107.

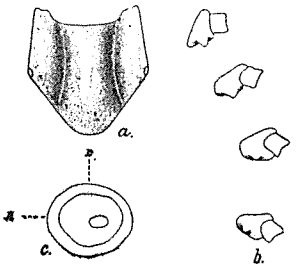
The capitulum is small and its length is 0·27—0·38 mm. The base is a broad hexagon in shape with the lateral saliences lying in the anterior half. It is three times as broad as long and has an almost complete transverse row of hairs on its dorsal surface. The dorsal ridge is almost straight with well-developed cornua. The palps are short, but are distinctly longer than broad. Article I is totally fused with article II. Article II is twice as long as article III and is narrow proximally : it bears a transverse ridge about the middle of its length, running across the dorsal, ventral and external sides, but most pronounced on the ventral side. A small blunt retroverted spur, hardly raised above the surface, is present on the ventral surface of the narrow proximal portion of article II. There are two simple hairs on its supra-internal margin and the same number of hairs on the infra-internal margin in front of the ridge. Article III is twice as broad as long ; it has a transverse ridge on the three sides in its posterior third, making a well-marked lateral salience externally. A short blunt retroverted process is present on the ventral aspect near the postero-internal angle. This article bears two simple hairs on its infra-internal margin close to the postero-internal angle. The hypostome has 4|4 rows of teeth with six to eight sharply pointed teeth in each row. The external cheliceral article has a large cusp and a very minute sub-ventral cusp. The dorsal process is bicuspid.

Female.—The body of the unfed female is an elongate-oval with the lateral sides almost parallel. Its size varies from 1·75×1·0 mm. to 2·5×1·5 mm. The colour is dark brown and the body is hairy. The

scutum is longer than broad and is 0·96×0·79 to 1·25×0·78 mm. in size. It is sub-pentagonal in shape with the antero-lateral sides parallel and the postero-lateral converging into a broadly rounded angle. The scutum is hairy and especially so in the region of the lateral fields. The cervical grooves, which are broad, shallow and parallel, reach the middle of the postero-lateral margins of the scutum. The median field separating the cervical grooves is twice as broad as a lateral field. In some specimens the median field is yellowish brown while the lateral fields are orange-rufous, in others the whole scutum is auburn in colour. The punctations are few and superficial and are sparsely scattered. The postero-lateral grooves extend up to the scutum and the median groove is confined to the posterior one-third of the body. The marginal grooves are absent. The spiracle is similar to that of the male. The legs are of a yellowish brown colour and the segments are comparatively longer and more slender than those of the male. Coxa I is triangular in shape but the apex is not so prolonged as in the male. There are two short broad tuberosities on its posterior border. The remaining coxal armature is similar to that of the male. Tarsus IV tapers gradually to a ventral spur that is longer than that of the male, and is preceded by a smaller one.

The capitulum is stronger than that of the male. Its length varies from 0·33 mm. to 0·48 mm. The cornua are short. The porose areas are broadly oval and the interval between them is equal to their largest diameter. The small retroverted spur that is present on the ventral aspect of article II of the male is absent in the female. The teeth of the hypostome are stronger than those of the male, especially those in the external rows. The external cheliceral article has three cusps of which the distal is small and sub-ventral in position. The dorsal process is crescent shaped with an additional cusp on the dorsal limb.

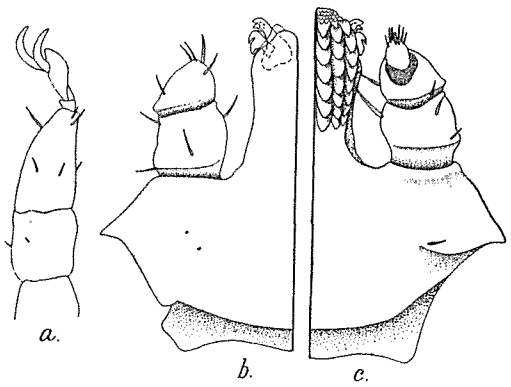
The largest replete female in the collection measures 12·0×7·5 mm. The body is oval with the lateral sides almost parallel.



TEXT-FIG. 28.—*Boophilus australis* nymph: (*a*) scutum, × 36; (*b*) coxal armature, × 36; (*c*) spiracle, × 100.

Nymph.—The scutum is pentagonal in shape with the angles somewhat rounded. It is longer than broad or in some cases as long as broad. The size is from 0·42×0·43 mm. to 0·5×0·46 mm. Its surface is smooth. The cervical grooves are sub-parallel, being slightly curved with the concavity towards the external side: they reach the middle of the postero lateral margins. The spiracle is sub-circular with a thick margin. Coxa I is sub-triangular with a single blunt posterior spur. Of the other

coxae each has a slight blunt spur in the middle of their length. Tarsus IV tapers gradually but is without any ventral spur. The pad is short and attains one-third the length of the claws.



TEXT-FIG. 29.—*Boophilus australis* nymph: (*a*) tarsus IV, × 150; (*b*) capitulum, dorsal aspect, × 140; (*c*) capitulum, ventral aspect, × 140.

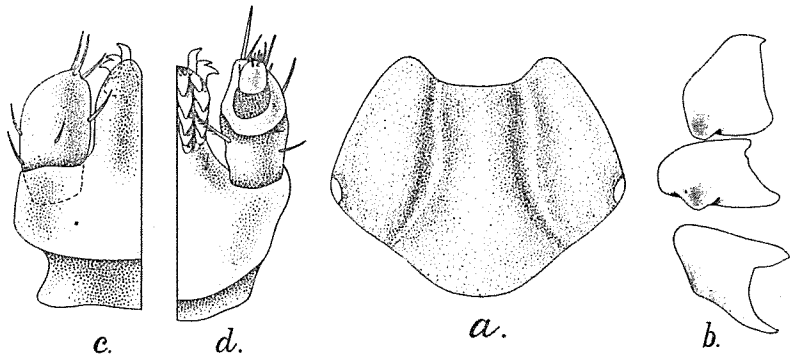
The capitulum is 0·2—0·27 mm. in length and is like that of the female. The lateral saliences of the base are situated about the middle of its length and are more pronounced than those of the adult. The cornua are short and blunt. The palps are twice as long as broad. The ridges on articles II and III are comparatively less developed than those in the adult. The hypostome has 3|3 rows of teeth with six blunt teeth in each row.

In the replete nymphs the body suddenly narrows behind the last pair of legs. This feature is sufficient to separate the nymphs of this species from those of other species of the allied genera.

Larva.—The body of the unfed larva is oval and is nearly as long as broad. The size varies from 0·4×0·42 mm. to 0·47×0·48 mm. The scutum is pentagonal in shape with the angles rounded and is broader than long. Its size varies from 0·27×0·35 mm. to 0·28×0·4 mm. The cervical grooves are broad and parallel anteriorly but they are narrow and divergent posteriorly. The emargination is moderate and the scapulae are blunt. The scutum has a smooth surface with less than ten minute sparsely scattered hairs. It covers more than the anterior half of the body of the unfed larva. Slight traces of the posterior six festoons are discernible. The venter has very few hairs. Coxa I has a short blunt spur on the internal angle and the other coxae have each a short broad spur in the middle of their length. Tarsus III tapers gradually and is without any spur.

The capitulum is 0·12—0·16 mm. in length. The base is rectangular without any lateral salience or cornu. Its dorsal surface is smooth and devoid of hairs. The ventral ridge is present and sub-semicircular in shape. In the palps the first three articles are totally fused. Each palp is club-shaped with the external outline entire and convex. Article II has a single feathery hair on the infra-internal and a simple hair on the supra-internal margin. Article III has a raised ridge on the ventral surface posterior to the depression for article IV. The hypostome

possesses 2|2 rows of teeth with five or six teeth in each row. In a few cases I have seen a further row of two or three teeth on each half, internal to the ones mentioned above.



TEXT-FIG. 30.—*Boophilus australis* larva: (*a*) scutum, × 110; (*b*) coxal armature, × 140; (*c*) capitulum, dorsal aspect, × 200; (*d*) capitulum, ventral aspect, × 200.

Distribution and hosts.—This species has a very wide range of distribution. In Asia it has been reported from the Philippine Islands, Borneo, Annam (Larrousse, 1925), Sumatra, India and Ceylon (Warburton, 1925). It is very common in Australia and according to Nicholls (1922) it has been imported into Tasmania from N. S. Wales. In Africa it has been reported from Egypt (King, 1908), the southern Provinces of Sudan (King, 1911), Portuguese East Africa (King, 1911) South Africa, Gold Coast (Simpson, 1914) and Sierra Leone (Yorke and Blacklock, 1915). In North America it is said to have been imported into Florida (Bishopp, 1913) and Southern Mexico—Tampico Mex—from the West Indies and Central America. In Central America it has been recorded from Guatemala, Costa Rica and Panama; in the West Indies from Cuba, Jamaica, Porto Rico, Antigua, Guadeloupe, Dominica and Trinidad; in South America from Venezuela, Dutch Guiana (Reyne, 1923), British Guiana, Brazil, Paraguay, Argentine, Uraguay and Chile.

In India it has been recorded from the Chin Hills, Shillong and from Muktesar in the Naini-Tal Dist. It is the common cattle tick in Burma, Assam, Bengal and the Andamans, but it is also very common, along with *Hyalomma* (*Hyalomma*) *aegyptium* (Linné), in Bihar and Orissa, the Central Provinces, Madras Presidency and the Southern districts of the Bombay Presidency. The new records from the Hazara District in N.-W. F. Province, Dalhousie in the Gurdaspore District, Dharmpore and Kasauli in the Simla Hills, Punjab, and the Naini-Tal District in the United Provinces are of some interest because, as far as the author is aware, the species is not found in the North-West Frontier Province, Punjab, Sindh, Baluchistan and the northern districts of the Bombay Presidency. The occurrence of this species at these disconnected places can only be explained on the assumption that the species is to be found all along the southern slopes of the whole of the Himalayas. It is the common cattle infesting tick and also sometimes attacks sheep, goat, horse, camel (rarely), nilgai, *Cervulus muntjac* (Zimm.) and *Bos frontalis* Lambert.

Boophilus annulatus subsp. **calcaratus** (Birula).

1911. *Margaropus annulatus calcaratus*, Neumann, *Das Tierreich* XXVI, p. 48.

Eight lots of ticks belonging to the Imperial Agricultural Research Institute, Pusa, collected at Coorg mostly from cattle and one lot from the horse are quite different from the specimens of *B. australis* which I have examined. The males are quite distinct from those of that species and I refer them to *Boophilus annulatus* subsp. *calcaratus* (Birula). The females, nymphs and larvae cannot be distinguished from the corresponding stages of *Boophilus australis*, but as these were found along with the males which are certainly examples of *B. annulatus* subsp. *calcaratus*, I am of the opinion that all these stages belong to *B. annulatus* subsp. *calcaratus* (Birula). Moreover, *B. australis* has not been recorded from Coorg.

Male.—This is smaller than that of *B. australis* and differs from it in some important points. The scutum is less hairy and the hairs are mostly confined to the lateral margins. The punctations are larger and the adanal and accessory shields are less chitinous than those of *B. australis*. The caudal appendage is absent. The following are the measurements of the males from Coorg.

Length	Breadth
1·4 mm.	0·9 mm.
1·3 mm.	0·8 mm.
1·5 mm.	0·9 mm.
1·7 mm.	1·0 mm.
1·4 mm.	0·8 mm.
1·6 mm.	0·9 mm.
1·4 mm.	0·8 mm.
1·6 mm.	1·1 mm.

Female.—This resembles the female of *B. australis* so closely that I have failed to find any definitely distinguishing points between the two. There are, however, a few minor points of difference. Generally speaking the females of this subspecies are smaller than those of *B. australis*. The postero-lateral sides of the scutum converge gradually to a more pointed posterior angle than in *B. australis*. The cornua are comparatively smaller than those of the latter species.

Nymph.—The posterior angle of the scutum is more pointed than that of *B. australis*. The cornua are absent, otherwise the capitulum is as in *B. australis*.

Larva.—It is like that of *B. australis*.

Distribution and hosts.—The distribution of the subspecies, as far as it has been recorded, is very disconnected. In Asia it has been recorded from Russian Turkestan (Yakimoff, 1917)—Tashkent, Ashabad, off camel; in Africa from Egypt, Abyssinia, the Congo Free States (Newstead, Dutton and Todd, 1907), Tunis, Algeria, Tangier (Charrier, 1925) and Morocco (Lavier, 1923); in Europe from Caucasia, Albania (Kotlán, 1921*b*) and Rumania. I have examined several ♂s ♀s Os *I*s, off cattle and horse from Coorg, and ♂s ♀s, off cattle from Mysore in S. India.

Genus **Dermacentor** Koch.

1778. *Acarus* (*en partim*), de Geer, *Mémoires pour servir à l'histoire des Insectes* VII, pp. 160, 161.
1794. *Acarus* (*en partim*), Fabricius, *Entomologia Systematica* IV, p. 425.
1804. *Cynorhaestes* (*en partim*), Hermann, *Mémoire Aptérologique* An XII, p. 63.
1805. *Ixodes* (*en partim*), Fabricius, *Systema Antliatorum*, p. 351.
1806. *Ixodes* (*en partim*), Latreille, *Genera Crustaceorum et Insectorum* I, pp. 155, 156.
1821. *Ixodes* (*en partim*), Say, *Journ. Acad. Nat. Sci. Philadelphia* II, p. 75.
1822. *Crotonus* (*en partim*), Duméril, *Dictionnaire des Sciences Naturelles*, XXIV, p. 56.
1826. *Ixodes* (*en partim*), Risso, *Histoire naturelle des principales productions de l'Europe méridionale* V, p. 182.
1844. *Ixodes* (*en partim*), Gervais: in Walckenaer's *Histoire naturelle des Insectes, Aptères* III, pp. 234-236.
1844. *Dermacentor*, Koch, *Arch. Naturgesch.* X (Bd. 1), p. 235.
1882. *Pseudixodes*, Haller, *Jahresh. Ver. Vaterl. Naturk. Württ.* XXXVIII, p. 311.
1897. *Dermacentor*, Neumann, *Mém. Soc. Zool. France* X, p. 360.
1908. *Dermacentor*, Bonnet, *Arch. Parasitol.* XII, p. 261.
1911. *Dermacentor*, Neumann, *Das Tierreich* XXVI, p. 98.
1911. *Dermacentor*, Nuttal, and Warburton, *Ticks* part 2, p. 120.
1913. *Dermacentor*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 624 (Madras).

In 1897 Supino described *Dermacentor auratus* [1], *D. feai* [1] *D. longipes* [2] and *D. indicus* [1] as four new species of this genus from Burma: of these the last was recognised by Neumann as identical with *Amblyomma sublaeve* Neum., while Supino's description of *D. longipes* and *D. feai*, as already pointed out by Neumann, is so meagre and insufficient that it is impossible to come to any conclusion about the validity of these species. The types are lost and they have been considered by Neumann[3] as doubtful species. The only Indian species of the genus, therefore, is the first. In 1901 Neumann described *D. compactus* as a new species from Borneo, Java, Sumatra and India. In 1905, however, he included it as a variety of *D. auratus* Supino. In the Indian Museum collection two species, *viz. D. auratus* Supino and *D. compactus* Neumann were recognised by Nuttall and Warburton. I have re-examined these specimens carefully and can find no differences between the so-called two species. I have, therefore, included both of them under the name *D. auratus*. Neumann's description of the varietal differences in both his papers is so meagre and contradictory that it is impossible to separate the form *compactus* from *typica*, and moreover the differences that he gives are so unimportant that I consider it best to include *D. auratus* subsp. *compactus* Neumann with *D. auratus* Supino.

Hirst (1926) has recently described *D. everestianus* from Tinki Dzong, Tibet (alt. 15,000 ft.); Mount Everest Expedition (Hingston Coll.). This species, which is represented by a single male specimen in the British Museum, differs from the only Indian species, *D. auratus*, in having "narrow elongated dark patches of coloration on the scutum; punctations on the scut m fine and numerous and coxa IV rather long and narrow, being furnished with a single spur."

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[1] Supino, *Atti. Soc. Veneto-Trent. Sci. Nat.* (2) III. pp. 235, 236 (1897).
[2] Supino, *ibid.*, p. 250, pl. xiii, fig. 13 (1897).
[3] Neumann, *Das Tierreich* XXVI, p. 104 (1911).

Dermacentor auratus Supino.

(Plate VIII, fig. 6 ; plate IX, fig. 1).

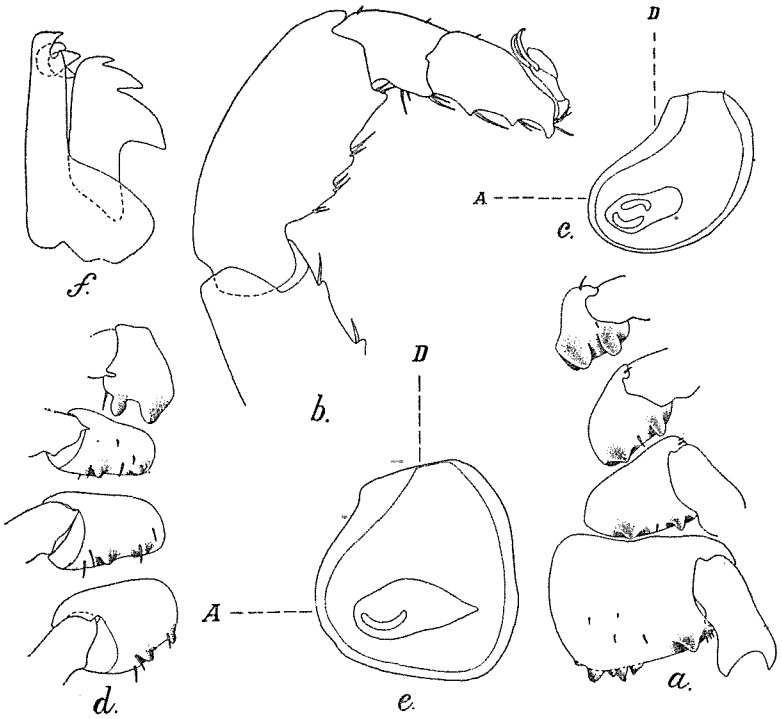
1897. *Dermacentor auratus*, Supino, *Atti. Soc. Veneto-Trent. Sci. Nat.* (2) III, p. 235, pl. xiii, fig. 14.
1897. *Dermacentor auratus*, Neumann, *Mém. Soc. Zool. France* X, p. 382.
1901. *Dermacentor compactus*, Neumann, *Mém. Soc. Zool. France* XIV, pp. 268, 269.
1902. *Dermacentor auratus*, Neumann, *Arch. Parasitol.* VI, pp. 126, 127.
1905. *Dermacentor auratus* var. *compactus*, Neumann, *Arch. Parasitol.* IX, p. 236.
1911. *Dermacentor auratus auratus* and *Dermacentor auratus compactus*, Neumann, *Das Tierreich* XXVI, p. 103.

Male.—The body is oval, narrowing anteriorly and is broadest in front of the spiracle. The following are measurements of males from different localities :—

		Length	Breadth
Reg. No. $\frac{2435}{17}$	Upper Burma	4·5 mm.	3·25 mm.
Reg. No. $\frac{9219}{H2}$	.. Nechal, Satara Dist.	6·5 mm.	5·2 mm.
Reg. No. $\frac{8799}{H2}$	.. Nagabera, Goalpara Dist. ..	4·2 mm.	3·5 mm.

The scutum possesses slightly raised brown stripes on a whitish background : the two sigmoid-shaped horns of the falciform stripe form the posterior boundary of the pseudo-scutum. The ocular spots are small and are fused with the horns of the falciform stripe which are formed by the fusion of the antero-accessory stripes with it. The falciform stripe has two backwardly directed short extensions of its horns. The pseudo-scutum has a median longitudinal stripe of somewhat irregular form which crosses the falciform stripe and is generally continued on posteriorly by the postero-median stripe : the latter is discontinuous in the middle. The postero-accessory stripes bend inwards. A brown band starts a little behind the eye and running along the margin ends near the extreme festoon. In some specimens three indistinct lateral spots are visible on each side. All the festoons with the exception of the third on each side, which is generally brown, are marked with white spots with brown margins, and each is strengthened on its postero-ventral surface by a brown scute. The festoons are longer than broad, with broad, brown separating grooves. The emargination is deep and the outer articulating process of the scapula is pointed. The cervical grooves are deep and slightly convergent anteriorly but are shallow and divergent posteriorly. They generally fall short of the posterior margin of the pseudo-scutum. The punctations are numerous and markedly unequal : the larger, of which there are many, are round and deep and are interspersed with much more numerous very fine ones. The larger punctations are absent along the stripes and are smaller in size on the scapular regions. The lateral grooves commence a little behind the eyes and each includes two extreme festoons of the same side : they are narrow and superficial and are generally formed of a single row of large punctations.

The genital aperture lies opposite coxa II and its lower margin is strengthened by a transverse chitinous plate. The anus is broader than long. The spiracle is short and comma-shaped, and the macula, which is twice as long as broad, is blunt at both ends. The legs are very strong

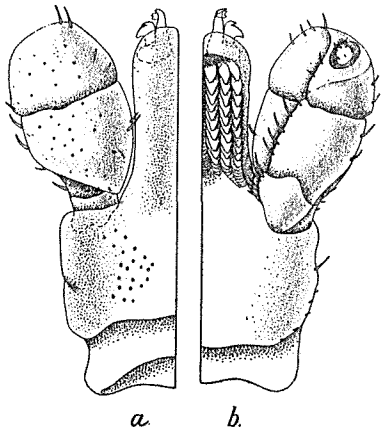


Text-fig. 31.—*Dermacentor auratus :* (*a*) ♂, coxal armature, × 16 ; (*b*) ♂, protarsus and tarsus IV, × 34 ; (*c*) ♂, spiracle, × 34 ; (*d*) ♀, coxal armature, × 16 ; (*e*) ♀, spiracle, ×34 ; (*f*) ♀, ventral view of the left digit, × 145.

and massive and are ornate with numerous whitish specks on the brown back-ground. They are also punctate. Coxae I, II and III have each two short, blunt, well separated and progressively decreasing spurs, the external being longer than the internal. Coxa IV is about twice the size of any other coxa and has two to four short spurs on the postero-internal and one near the postero-external angle. The segments of the legs have blunt spine-like processes on their ventral surfaces. The length of the proximal portion of tarsus I is four times that of the distal portion. Tarsus IV has the pseudo-articulation about the middle and tapers gradually to a strong and pointed spur, which is preceded by two short spurs on the ventral side. The pad attains about half the length of the claws.

The entire capitulum is about one and a half times as long as broad. The dorsal surface of the base and of the palps is ornate and punctate. Its length is 1·2 mm. The base is twice as broad as long and is rectangular with straight lateral sides. The cornua are broad and short. The palps are twice as long as broad with articles II and III sub-equal. Article I is small and only partially visible on the dorsal aspect : it is

partially fused with article II. Its antero-internal angle on the dorsal surface is pointed and is concealed by a dorsal retroverted prominence of article II. On the ventral surface it bears a triangular plate bearing five simple hairs. Article II is the largest and is as broad as long. It is



TEXT-FIG. 32.—*Dermacentor auratus* ♂: (*a*) capitulum, dorsal aspect, × 33; (*b*) capitulum, ventral aspect, × 33.

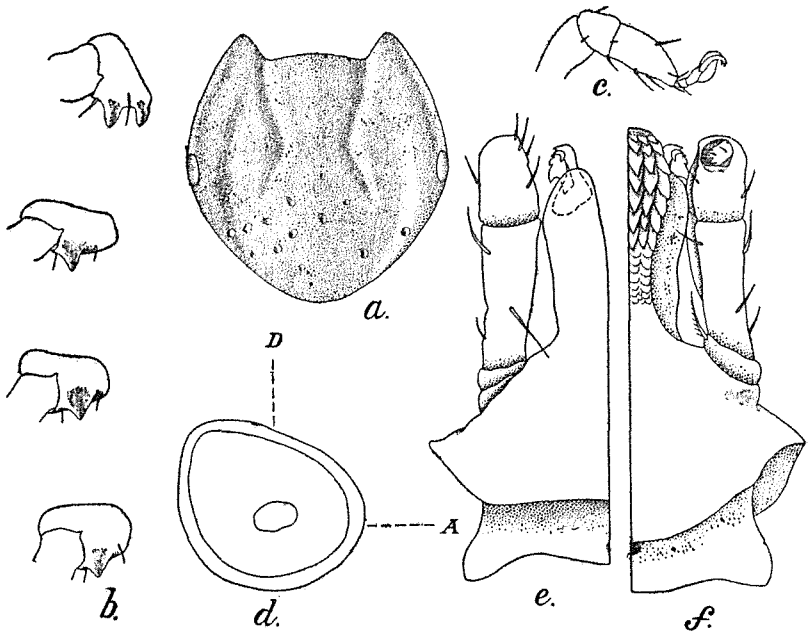
narrow proximally and is broadest in the middle. There is an oblique dorsal ridge on its posterior half defining a posterior retroverted prominence. It usually bears two simple hairs on the supra-internal margin and five simple hairs on the infra-internal margin. Article III is broader than long and bears a ventral obsolete ridge posterior to the depression for article IV which is very small. The hypostome has 3|3 rows of teeth with about ten equal size teeth in each row: these are followed by a few scale-like teeth. The number of teeth decreases as one passes from the external to the internal row. The external cheliceral article bears two cusps, the distal being small and sub-ventral in position. The dorsal process is hastate in shape with two cusps pointing laterally.

Female.—The size of the smallest female in the collection is 3·7 × 2·8 mm. Its body is oval, narrowing slightly towards the anterior end, and is broadest in front of the spiracle. The scutum is broad sub-hexagonal, being broadest in the anterior one-third. The following are the measurements of the scutum of females from different localities :—

		Length	Breadth
Reg. No. $\frac{9219}{H2}$	.. Nechal, Satara Dist.	2·5 mm.	3·0 mm.
Reg. No. $\frac{979}{17}$	.. Songra, Gonda Dist.	2·1 mm.	2·4 mm.
Reg. No. $\frac{978}{17}$	.. Chandan Chowki, Naini-Tal Dist. ..	2·3 mm.	2·7 mm.
Reg. No. $\frac{1798}{17}$	.. Arakan Yomas, Chauung, Upper Burma	1·7 mm.	2·0 mm.

The eyes are yellow in colour and are flat; they are situated at the posterior end of the anterior third of the scutum. The scutum is ornate.

The ocular spot is fairly well developed and is continued posteriorly by a narrow limiting stripe which runs along the posterior margin behind the eye and meets its fellow of the opposite side at the posterior end of the scutum. There is a further median stripe which extends to a little in front of the posterior half of the scutum. Faint cervical stripes were observed in one specimen but in others they are absent. The cervical grooves are at first deep and convergent, but further back they become shallow and divergent and hardly reach the posterior margin of the scutum. The lateral groove is ill-defined and poorly developed ; it and the cervical groove of the side enclose an oval superficially depressed cervical field. The punctations are large, circular and numerous and interspersed with very fine ones. The punctations on the scapular regions are smaller than the rest and are absent on the brown stripes. The marginal groove is narrow and includes three festoons of the same side. The general dorsal surface is hairy and wrinkled. The genital aperture lies opposite coxa II. The spiracle is sub-triangular with the dorsal angle strongly truncated. The posterior end of the macula is pointed. The leg-segments are as in the male, but are somewhat longer. The coxae are comparatively longer than those of the male and are sub-equal in size. Coxa I has two spurs as in the male. Coxae II-IV have each two sub-equal spurs. Tarsus IV bears spurs that are comparatively stronger than those in the male.



TEXT-FIG. 33.—*Dermacentor auratus* nymph : (*a*) scutum, × 71 ; (*b*) coxal armature, ×55 ; (*c*) tarsus IV, × 55 ; (*d*) spiracle, × 140 ; (*e*) capitulum, dorsal aspect, × 128 ; (*f*) capitulum, ventral aspect, × 128.

The capitulum is 1·5 mm. in length and is comparatively longer than that of the male. The dorsal surfaces of the palps and the base, like those of the male, are ornate and punctate. The cornua are stronger than those

of the male. The porose areas are oval and are broader than long, the interval between them being equal to the shortest diameter. The palps are longer than those of the male with article II much longer than article III. Article III is longer than broad. The teeth of the hypostome are both stronger and more numerous than those in the male. The external cheliceral article bears three cusps. The dorsal process has two cusps and the dorsal limb bears a blunt and rounded prominence.

Nymph.—The scutum is sub-hexagonal, being broadest in the middle. Its size is 0·5×0·54 mm. It is brown in colour, changing to reddish brown near the eyes. The cervical grooves are anteriorly deep and convergent; they then become divergent and superficial and finally disappear in the posterior third of the scutum. The lateral grooves are shallow and superficial and together with the cervical grooves enclose superficial cervical fields. There are ill-defined superficial grooves along the antero-lateral margins of the scutum. The punctations are few and superficial, and are present only in the posterior portion of the median field. The spiracle is pear-shaped. Coxa I has two fairly strong, well separated and equal spurs. Coxae II-IV have each a pointed triangular spur near the external angle. Tarsus IV tapers gradually and is without any ventral spur. The pad attains two-thirds the length of the claws.

The capitulum differs considerably from that of the adult. It is 0·38 mm. in length. The base is hexagonal in shape with the lateral angles strongly pointed and salient; it is two and a half times as broad as long. The cornua are absent. The palps are long, being four times as long as broad. All the articles of the palps are distinct. Article I bears a long slightly feathery hair on its infra-internal margin. Article II is twice as long as article III and is without any ridge or salience: it bears one long hair on its supra-internal and one hair on the infra-internal margin. Article III is longer than broad. The hypostome is strongly spatulate and possesses 3|3 rows of teeth with six strong teeth in each row in the anterior half, and these are followed by 2|2 rows of seven scale-like teeth.

My description of the nymph of this species is based on a single example taken off Babu D. N. Bagchi's neck: it became attached to his neck during his ride through the jungle near Ghoom on the 19th December, 1926. It was taken off his neck on the 22nd morning and in the evening it was put on a guinea-pig from which it dropped off, fully fed, on the 24th evening. The adult male emerged from it on the 22nd January, 1927. The type-specimen of the nymph [a mounted slide of the cast-skin (Reg. No· $\frac{59}{18}$)] is in the Indian Museum.

Distribution and hosts.—The species has so far been recorded from Borneo [11 ♂s 11 ♀s, off *Potamochœrus larvatus* (F. Cuv.)], Java [4 ♂s ♀ off *Sus vittatus* Temm.], Sumatra (1 ♀), Carin-Chela and Mooleyet in Burma (off *Ursus torquatus* Wagn. and *Sus cristatus* Wagn.) and India (1 ♂, off bear). Warburton (1925) has recently recorded it off a bear and Nias pig in Ceylon. He (1926a and b) also records it from Pulu Bibi and Sungai Kumbang (Korintji) in Sumatra. The following new records show that the distribution of the species extends almost throughout

India. It normally attacks only wild animals and hence is of little economic importance.

Burma.—Arakan Yomas, Chauung, Upper Myinudaung Reserve in the Henzada Dist. (♀, host unknown) and (♂, host unknown), Upper Burma without exact locality.

Assam.—Nagabera in the Goalpara Dist. (♂s ♀, off wild boar).

Bengal.—Ghoom in the Darjeeling Dist. (♂, reared from a nymph taken off Babu D. N. Bagchi). Naihati (0, off deer, C. S. T. M. Coll. and 0, off man, C. S. T. M. Coll.) and Calcutta (0s, off man, C. S. T. M. Coll.), both in the Twenty-four Parganas Dist.

Bihar and Orissa.—Luia, S. W. Chaibassa in the Singhbhum Dist. (♂s, off wild pig).

United Provinces.—Chandan Chowki (♀, off *Felis pardus* Linn.) and Bhowali (♀, found on the clothing of Dr. Sundra Rao on his return from the jungle), both in the Naini-Tal Dist. Songra in the Gonda Dist. [♀, off *Melursus ursinus*] (Shaw)].

Bombay Presidency.—Helvak, 2,000 ft. alt., Koyna Valley (♀, host unknown) and Nechal, W. Ghats, 2,000 ft. alt. (♂, host unknown), both in the Satara Dist.

Genus **Nosomma** Schulze.

1911. *Hyalomma (en partim)*, Nuttall and Warburton, *Ticks* part 2, p. 125.
1919. *Nosomma*, Schulze, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1919, pp. 191, 192.

In 1919 Schulze created this genus to include *Hyalomma monstrosum* Nuttall and Warburton without actually seeing the species and without giving sufficient reasons for the creation of this new genus: previously Nuttall and Warburton had with some hesitation assigned this species to the genus *Hyalomma* Koch.

I consider that *Nosomma* is a good genus intermediate between *Hyalomma* Koch and *Dermacentor* Koch, but more allied to the latter than the former. The base in the female of *Nosomma monstrosum* (Nuttall and Warburton), the type-species of the genus, is rectangular as in the genus *Dermacentor* and not sub-triangular or broad hexagonal as in the genus *Hyalomma*. In both the sexes of *N. monstrosum* the entire capitulum resembles that of the genus *Dermacentor*. The eyes are flat, as in the genus *Dermacentor*, and not spherical and orbital as in *Hyalomma*. The coxal armature, leg ornamentation, tarsal spurs and spiracle of the type-species of this genus are like those of *Dermacentor auratus*. The species would certainly have been assigned to the genus *Dermacentor* if the ventral shields, the only point in common with the genus *Hyalomma*, were absent in the males. The affinities of *Hyalomma* with *Dermacentor* through *Nosomma*, therefore; suggest that *Hyalomma* also should be included with the *Rhipicephalus* group of genera and not with the *Amblyomma* group, as has been done by Nuttall and Warburton.

I define the genus Schulze as follows:—

Eyes flat; scutum, legs and the dorsal surface of the capitulum ornate; festoons present; palps short and broad; base rectangular dorsally

in both sexes ; coxa I bifid ; other coxae with two short spurs on each ; ventral shields represented by adanal, accessory and trilobed sub-anal shields ; spiracle short comma-shaped in the male and sub-triangular in the female.

The genus is represented solely by the type-species *Hyalomma monstrosum* Nuttall and Warburton, and has hitherto only been recorded from India.

Nosomma monstrosum (Nuttall and Warburton).

1908. *Hyalomma monstrosum*, Nuttall and Warburton, *Proc. Cambridge Phil. Soc.* XIV, pp. 414-416, text-figs. 41-45.
1918. *Hyalomma monstrosum*, Warburton, *Parasitology* X, pp. 284, 285, text-fig. 1.
1919. *Nosomma monstrosum*, Schulze, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1919, pp. 191, 192.
1924. *Nosomma monstrosum*, Chodziesner, *Zool. Jahrbücher* (Abt. Syst.) XLVII, pp. 529, 530.

Male.—The scutum is Kaiser-brown to chestnut-brown in colour. A whitish ornamental secretion is visible all over the scutum in fresh specimens but becomes less visible in specimens preserved in alcohol for any length of time. The punctations are markedly unequal ; the finer ones are only visible when the specimens are examined in alcohol. The cervical grooves are represented anteriorly by short, oval, deep and slightly convergent depressions, and the posterior diverging portions are either superficial or obsolete. The postero-median groove is narrow and poorly developed, shorter than the postero-lateral grooves, which are broad and well developed. The lateral groove is narrow and is rendered conspicuous on account of a row of punctations lying next to it. This row of punctations is generally continued over the pseudo-scutum up to the scapular region. Usually the pseudo-scutum is well defined, but in the two male specimens from Hornia village, the posterior margin is only faintly indicated by a shallow ill defined furrow. The eyes are flat. The eleven festoons have well developed separating grooves on the scutum and bear eleven prominent scutes[1] on the ventral side.

The venter is either light brown or yellowish white. The sub-anal shield is trilobed and the fourth lobe is the accessory shield and is strongly chitinised in the centre. The spiracle is comma-shaped with the tail end short and broad ; it is twice as long as broad. The legs are Kaiser-brown to chestnut-brown in colour with whitish ornamental patterns present on all the legs, clearly visible when the specimens are examined in alcohol. Coxa I has two well-separated unequal spurs, the external being twice as long as the internal. Coxae II-IV[2] have each two short sub-equal well-separated spurs but those on coxa IV are better developed than those on the others. Tarsus IV tapers gradually to two strong ventral spurs of which the distal one is considerably stronger than

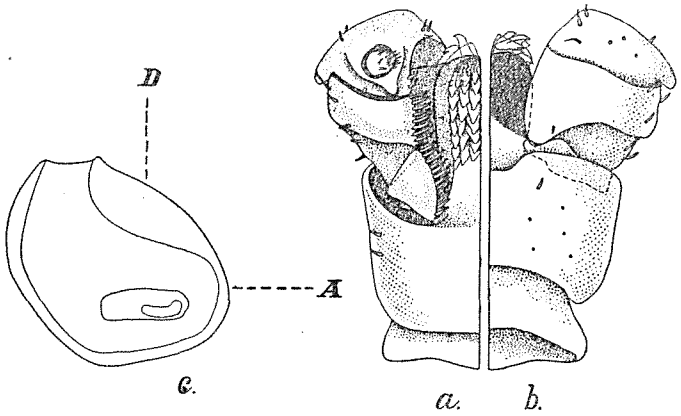
[1] Schulze's remark (*vide* Schulze, *loc. cit.*, p. 192) " Ausserdem fehlen bei beiden die Peltae " about this species is not correct.

[2] Chodziesner's statement (*vide* Chodziesner, *loc. cit.* p. 529) "Coxa III mit einem (Zahn)" is probably based on the slightly defective diagram of the male published by Nuttall and Warburton.

the other. Its distal portion is one and a half times as long as the proximal. The pad attains one-third the length of the claws.

The following are measurements of males from different localities :—

		Length	Breadth
C. S. T. M. No. 384 ..	Locality unknown ..	.. 4·2 mm.	3·2 mm.
Reg. No. $\frac{81}{18}$ ..	Angul Agricultural Farm	.. 3·6 mm.	2·8 mm.
Reg. No. $\frac{9225}{H2}$ ..	Hornia village, Hazaribagh Dist.	.. 3·2 mm. 3·6 mm.	2·5 mm. 2·9 mm.
Reg. No. $\frac{9226}{H2}$ ..	Bombay Presidency ..	.. 4·2 mm.	3·0 mm.



TEXT-FIG. 34.—*Nosomma monstrosum* : (*a*) ♂, capitulum, ventral aspect, × 72 ; (*b*) ♂, capitulum, dorsal aspect, × 72 ; (*c*) ♀, spiracle, × 47.

The capitulum is 0·71—0·75 mm. in length. The dorsal surface of the base and the palps are covered with a whitish ornamental secretion. The base is rectangular in shape and is nearly twice as broad as long. The palps are one and a half times as long as broad. Article I is distinctly separated dorsally and its antero-internal angle is produced into a lobe-like process. Ventrally it is partially fused with article II and bears a plate carrying about ten strong sabre-shaped hairs. Article II is twice as long as article III and is broader than long. Its proximal half is narrow : there is an oblique dorsal ridge running round the middle and joining a less developed ventral ridge, thus making a sort of lateral salience. This oblique dorsal ridge bears a dorsal retroverted prominence on the dorsal side. Article II usually bears ten sabre-shaped hairs on the infra-internal margin. Article III is twice as broad as long with a strong external process near the proximal end and a moderately strong ventral retroverted spur. The hypostome has 3|3 rows of teeth with seven strong teeth in each row.

Female.—The colour of the scutum is chestnut-brown with a diffused whitish ornamentation all over except on the margin. The cervical grooves are narrow, deep and convergent at first ; they then diverge and do not reach the posterior margin of the scutum. The punctations are strongly unequal. The finer ones are numerous and are clearly visible

when the scutum is seen submerged in alcohol. The marginal grooves [1] are not continuous and include only the two extreme festoons posteriorly. The ornamentation on the legs, palps, base and scutum is better developed than that in the male. The following are the measurements of the scutum of females from different localities :—

		Length.	Breadth
Reg. No. $\frac{63}{18}$ ..	Phulbani	1·5 mm.	1·9 mm.
Reg. No. $\frac{58}{18}$ ..	Simdega	1·9 mm.	2·1 mm.
Reg. No. $\frac{9225}{H2}$ ..	Hornia village, Hazaribagh Dist. ..	1·7 mm.	2·0 mm.
		1·75 mm.	2·2 mm.
		1·9 mm.	2·0 mm.

The spiracle is sub-triangular with the dorsal angle somewhat truncate, and is as long as broad. The coxal armature is as in the male. Tarsus IV tapers gradually to a ventral spur which is rather stronger than that in the male, and is preceded by a small ventral spur.

The capitulum is 0·85 mm. in length. The porose areas are long and oval, with the interval between them equal to one half of the greatest diameter. There is an obsolete lateral salience on palpal article III. The hypostome has 3|3 rows of teeth with about nine strong teeth in each row. The external cheliceral article has three cusps, the distal being small and sub-ventral in position. The dorsal process is crescent-shaped.

Distribution and hosts.—This species has so far been recorded by Nuttall and Warburton from the Chin Hills, E. of Chittagong (♂, off horse), Barhi near Hazaribagh in Bihar (♀, off *Sus cristatus* Wagner), Angul in Orissa (2 ♂s, off buffalo) and the Bombay Presidency (♂, from an unknown host.) I have seen specimens from the following localities :—

Bengal.—Adara jungle in the Midnapore Dist. (♂, off Sambhar *Cervus unicolor*, C. S. T. M. Coll.).

Bihar and Orissa.—Hornia village in the Hazaribagh Dist. (♂s ♀s, off bear). Sambalpur (♀, off buffalo). Simdega in the Ranchi Dist. (♂s ♀s, off dog). Angul Agricultural Farm (♂, off buffalo) and Phulbani (♀s, off bullock), both in the Angul Dist.

Genus **Hyalomma** Koch.

1758. *Acarus* (*en partim*), Linnaeus, *Systema Naturae* (Ed. X), p. 615.
1794. *Acarus* (*en partim*), Fabricius, *Entomologia Systematica* IV, p. 425 (Hafniae).
1804. *Cynorhaestes* (*en partim*), Hermann, *Mémoire Aptérologique* An. XII, p. 63 (Strasbourg).
1805. *Ixodes* (*en partim*), Fabricius, *Systema Antliatorum*, p. 351 (Brunsvigae).
1844. *Ixodes* (*en partim*), Gervais: in Walckenaer's *Histoire naturelle des Insectes, Aptères* III, pp. 234-236.
1844. *Hyalomma* (*en partim*), Koch, *Arch. Naturgesch.* X (Bd. 1), pp. 220-223.
1847. *Hyalomma* (*en partim*), Koch, *Übersicht des Arachnidensystems* Heft 4, pp. 13-15 (Nürnberg).
1880. *Ixodes* (*en partim*), Mégnin, *Les Parasites et les Maladies Parasitaires*, p. 121, (Paris).

[1] Chodziesner's statement "Marginalfurche fortlaufend." is incorrect. Probably she has confused the marginal with the lateral grooves which, as is stated by Warburton, are continuous. I have examined a dozen females of this species and find the marginal grooves are not continuous.

1899. *Hyalomma (en partim)*, Neumann, *Mém. Soc. Zool. France* XII, pp. 283-285.
1911. *Hyalomma (en partim)*, Neumann, *Das Tierreich* XXVI, p. 50.
1911. *Hyalomma (en partim)*, Nuttall and Warburton, *Ticks* part 2, p. 125.
1913. *Hyalomma (en partim)*, Patton and Cragg, *A Text-book of Medical Entomology*, p. 609 (Madras).
1919. *Hyalomma*, Schulze, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1919, pp. 189-196.
1922. *Hyalomma*, Senevet, *Arc. Inst. Pasteur Afriq. Nord.* II, pp. 393-396.
1924. *Hyalomma*, Chodziesner, *Zool. Jahrbücher* (Abt. Syst.) XLVII, pp. 531-543.

This genus, as defined by Nuttall and Warburton in 1911, contains, in addition to other species, *Hyalomma hippopotamense* (Denny) and *Hyalomma monstrosum* Nuttall and Warburton. Schulze has since separated these two species in two new genera, namely *Cosmiomma* and *Nosomma* respectively. I agree with Schulze's arrangement and define the genus *Hyalomma* as follows.

Palps long; base sub-rectangular or broad hexagonal dorsally; eyes spherical and orbital; ornamentation present or absent, when present generally confined to legs; festoons present; coxa I bifid. Female approaching *Amblyomma*, with spiracle sub-triangular. Male with adanal and accessory shields well developed; sub-anal shields present or absent; spiracle comma-or retort-shaped; tarsi with two strong ventral spurs.

Schulze divides this genus into two subgenera *Hyalomma* and *Hyalommina* which can be distinguished by the following key.

MALES.

I. Sub-anal shields present; tarsi not humped; base rectangular dorsally	*Hyalomma.*
II. Sub-anal shields absent; tarsi humped; base broad hexagonal dorsally	*Hyalommina.*

FEMALES.

I. Tarsi not humped; base sub-triangular with lateral saliences less prominent	*Hyalomma.*
II. Tarsi humped, base broad hexagonal with lateral saliences more prominent	*Hyalommina.*

Subgenus **Hyalomma** Koch.

This subgenus is represented by two Indian species, of which three Indian subspecies can be distinguished in the case of *Hyalomma* (*Hyalomma*) *aegyptium.*

Key to the Indian species and subspecies of the subgenus *Hyalomma.*

MALES.

I. Coxa I not deeply cleft (with two sub-equal short well separated spurs); posterior border of the adanal shield longer than the internal	*syriacum.*
II. Coxa I deeply cleft (with two unequal closely placed spurs); posterior border of the adanal shield shorter than the internal.	

A. Palps comparatively short with a lateral salience on article III ; segments of the last three pairs of legs much stronger than the first pair .. .. *aegyptium* subsp. *dromedarii.*

B. Palps comparatively long without a lateral salience on article III ; segments of all legs almost equally strong.

I. Leg segments with whitish rings on the joints.

A. White rings broad, not sharply defined and fading into the brown colour of the legs ; comparatively small in size ; spiracle retort-shaped .. *aegyptium forma typica.*

B. Whitish rings narrow and sharply defined ; comparatively large in size ; spiracle comma-shaped .. *aegyptium* subsp. *isaaci.*

II. Leg segments without whitish rings on the joints, but with a sharply defined white streak on the external surface of the segments of all legs .. .. *aegyptium* subsp. *ferozedini.*

FEMALES.

I. Coxa I not deeply cleft .. .. .. *syriacum.*

II. Coxa I deeply cleft.

A. Legs wihout whitish rings on joints, but with a sharply defined longitudinal streak on the external surface of segments of all legs .. *aegyptium* subsp. *ferozedini.*

B. Legs with whitish rings on the joints.

I. Legs with sharply defined brown and narrow whitish rings .. .. *aegyptium* subsp. *isaaci.*

II. Legs without sharply defined rings, the brown and white colours fading into each other .. .. .. *aegyptium forma typica.*

Hyalomma (Hyalomma) aegyptium forma typica (Linné).

1758. *Acarus aegyptius,* Linnaeus, *Systema Naturae* (Ed. X), p. 615.

1847. *Hyalomma rufipes, truncatum, hispanum* and *excavatum,* Koch, *Übersicht des Arachnidensystems* Heft 4, pp. 38, 39, 40-42, 45, 46, pl. iv, figs. 12, 13, 15, pl. v., figs. 16, 17, 18, pl. vi, fig. 22 (Nürnberg).

1857. *Ixodes cornuger* and *hispanus,* Kolenati, *Bull. Soc. Imp. Nat. Moscou* XXX, pp. 431-434, pl. vi, fig. 52.

1877.[1] *Hyalomma cornuger* and *hispanicum,* Murray, *Economic Entomology, Aptera,* pp. 196-198 (London).

1899. *Hyalomma aegyptium* (*en partim*), Neumann, *Mém. Soc. Zool. France* XII, pp. 285-291, text-figs. 58-60.

1905. *Hyalomma aegyptium,* Dönitz, *Sitzungsb. Ges. Naturf. Fr unde Berlin,* Jahrg. 1905. pp. 130-132.

1907.[2] *Hyalomma aegyptium,* Warburton, *Bull. Imp. Dept. Agric. India,* No. 6, p. 11, text-figs. 10, 14.

1908. *Hyalomma aegyptium,* Bonnet, *Arch. Parasitol.* XII, pp. 258, 259, text-figs. 24, 25.

1908. *Hyalomma aegyptium* (*en partim*), Howard, *Ann. Transvaal Mus.* pp. 99-102, pl. v, figs. e, f, n.

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[1] Neumann (*vide Das Tierreich* XXVI, p. 130.) considers *I. cornuger* Kolenati as synonymous with *H. syriacum* which is not the case as the diagram of *I. cornuger* obviously is that of *H.* (*Hyalomma*) *aegyptium.*

[2] Two figures have been wrongly indicated in this work. Text-fig. 15 is that of *Rhipicephalus haemaphysaloides* Supino and text-fig. 14 is that of *Hyalomma* (*Hyalomma*) *aegyptium* (Linné).

1911.[1] *Hyalomma aegyptium aegyptium*, Neumann, *Das Tierreich* XXVI, pp. 50, 51, text-figs. 26, 27.
1913. *Hyalomma aegyptium*, Patton and Cragg, *A Textbook of Medical Entomology*, pp. 609, 610, pl. lxxii, figs. 1, 3 (Madras).
1922. *Hyalomma aegyptium aegyptium*, Senevet, *Arch. Inst. Pasteur Afriq. Nord* II, pp. 409—411.
1924.[2] *Hyalomma aegyptium*, Sharif, *Bull. Agric. Res. Inst. Pusa*, No. 152, pp. 1-23, pls. i-v.
1924. *Hyalomma* (*Hyalomma*) *aegyptium* subsp. *aegyptium forma typica* and *forma excavata*, Chodziesner, *Zool. Jahrbücher* (Abt. Syst.), XLVII, pp. 547-549, text-figs. H, N, R, V, Y, E^1, F^1, J^1, K^1.
1926. *Hyalomma aegyptium* (*en patrim*), Fielding, *Commonwealth Australia Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, pp. 74-77, text-fig. 31.

Male.—This varies considerably in size, colour and structure in this species. Three forms of the typical subspecies have been recognized but on examination of a large series it was found that they are not quite distinct but tend to merge into one another.

One form resembles *H.* (*H.*) *aegyptium* subsp. *aegyptium forma excavata* Koch in having a posterior depressed area and white parma. The latter structure is very variable; in some it is very distinct but in others it is on the verge of disappearing and in others again is totally absent. This white parma, as I understand it from an examination of several thousand male specimens, is due to a strongly variable notch of the scutum in the middle of the posterior margin opposite to the middle festoon. Generally in a fed male of this species there is a slight extension of the body beyond the posterior margin of the scutum, and as a result the white parma becomes more distinct and larger than in poorly fed males, in which it is in some cases hardly visible. Thus the white parma is a more or less temporary structure. In view of the above I consider *forma excavata* Koch in no way distinct from the *forma typica*.

The second form shows certain resemblances to *H.* (*H.*) *aegyptium* subsp. *dromedarii* Koch but is considerably smaller. The white parma in this case also is very variable. In some specimens it is very distinct and in others is totally absent. The inner margin of the adanal shield is produced in the middle into a process running parallel to the anal groove. This also varies in size from an obsolete to a strongly developed process.

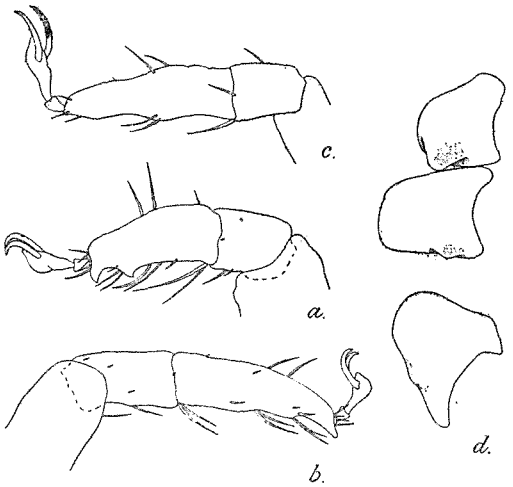
The Indian form is undoubtedly the *forma typica* but it differs from Chodziesner's description of *H.* (*H.*) *aegyptium* subsp. *aegyptium forma typica* in the following respects. The size of the male varies from 2·1× 1·6 mm. to 4·0×2·8 mm. The lateral groove is poorly developed and is indicated anteriorly by a row of large punctations and in the neighbourhood of the spiracle by a regular long depression. The anterior portion of the groove may be altogether absent. The cervical grooves

[1] I agree in the main with Neumann's synonymy given in this work, but differ from him in the following points: (1) *Ixodes gracilentus* Lucas [*Ann. Soc. Entom. France* (2) IV, p. 58, pl. i, fig. 2 (1846)] and *Ophiodes gracilentus*, Murray [(*Economic Entomology, Aptera*, p. 204 (London, 1877)] are not synonymous with *H. aegyptium* (Linné). The nymphs mentioned therein are probably those of the genus *Aponomma*. (2) *Cynorhaestes aegyptius*, Hermann, [(*Mémoire Aptérologique* An. XII, pp. 66, pl. iv, fig. 9 and l, and pl. vi, fig. 13. (Strasbourg, 1804)] is not synonymous with *H. aegyptium* (Linn.), but is undoubtedly *H. syriacum* Koch, as the figure of the male has the general appearance of *H. syriacum* and has eleven festoons with distinct separating grooves on the scutum. Moreover the host is a tortoise.

[2] For a detailed description of this species see this paper.

are at first broad, deep and convergent but become narrow and divergent towards their posterior ends. They are continuous in most cases with the postero-lateral grooves. The postero-median groove occupies the smaller posterior half but is in some cases continued anteriorly by a superficial groove between the cervical grooves. Each postero-lateral groove encloses the fourth festoon of the side and is interrupted at the level of the spiracle. The punctations show considerable variation. Normally there are but few sparsely scattered, large punctations interspersed with numerous close-set fine punctations; but in some the finer ones become so small as to be hardly visible especially in the anterior half, while the larger ones are very conspicuous. In others the finer punctations are a little larger and the larger ones slightly smaller and as a result all the punctations are sub-equal. In larger specimens there are eleven scutes but in smaller ones the number is reduced to six. There are eleven distinct festoons but only five or seven of the median ones have well-defined grooves on the scutum. The spiracle is retort-shaped. The legs are brown with white rings and markings merging into the ground colour. Coxa I has two strongly unequal and closely placed strong spurs. Coxae II and III have each a short spur near the external angle and a broad ridge-like tuberosity on the internal angle. Coxa IV has two very short spurs, one near the internal and another near the external angle. Tarsus IV has two strong and pointed ventral spurs. The pad attains a little more than one-third the length of the claws.

The capitulum is 0·58—1·2 mm. in length. The base is less than twice as broad as long. The cornua are short and blunt. The palps are three times as long as broad and are hollowed out dorsally.



TEXT-FIG. 35.—*Hyalomma* (*Hyalomma*) *aegyptium*: (*a*) ♂, tarsus IV, × 34; (*b*) ♀, tarsus IV, × 34; (*c*) larva, tarsus III, × 155; (*d*) larva, coxal armature, × 155.

Female.—The scutum is sub-hexagonal. It is either as long as or slightly longer than broad. Its size varies from 1·7 × 1·5 mm. to 2·1 × 1·9 mm. The cervical grooves are at first convergent, but posteriorly they diverge and reach the posterior margin. The lateral grooves are not well defined and in some cases are only indicated by a row of large

fused punctations. The punctations are unequal, the larger ones are few in number and are sparsely scattered, but the finer ones are numerous. In some cases the punctations tend to be sub-equal. The leg segments are longer and more slender than those in the male and the white markings on the leg segments are much more conspicuous. In some the last pair of legs have distinctly defined reddish-brown and white rings. The coxal armature is similar to that of the male, but the internal spur on coxa IV is somewhat reduced in size. The proximal portion of tarsus IV is one-half the length of the distal portion, which tapers gradually into a strong blunt ventral spur. The second spur is obsolete.

The base of the capitulum is sub-rectangular with the lateral saliences in the posterior half, thus making it appear somewhat sub-triangular. It is twice as broad as long and is without cornua. The porose areas are small and are elongate oval in shape, the interval between them being less than their largest diameter.

One replete female in the collection is $22{\cdot}0 \times 12{\cdot}5$ mm. in size.

Nymph.—The scutum is either as broad as or broader than long. Its size varies from $0{\cdot}5 \times 0{\cdot}52$ mm. to $0{\cdot}58 \times 0{\cdot}58$ mm. The punctations are rather rough but few in number. The spiracle is oval with the dorsal side nearly straight.

Larva.—The coxal armature of the larva is different from that of the other stages. There is only one short blunt spur on the internal angle of coxa I. Coxae II and III have each an obsolete spur near the middle of their length. The distal half of the distal portion of tarsus IV narrows considerably towards the distal end, and is without any spur.

Distribution and hosts—The original home of this species is, I think, the Mediterranean sub-region whence it has migrated to other adjoining countries. The hosts of this species are mostly cattle and it is probable that they are responsible for its wide distribution. In Asia it has been recorded from Siberia (Yakimoff, Kohl—Yakimoff, 1911), Mongolia, China, Eastern Turkestan, India, Ceylon, Turkestan—Bokhara, Tashkent and Ashabad—(Yakimoff, Kohl—Yakimoff, 1911), Afghanistan—Koscha on the Russo-Afghan Frontier—, Persia, Uralask (Yakimoff, 1922), Tourgai, Arabia, Petrae (Mann, 1915), Sinaitic Peninsula and Asia Minor. It has been imported into Australia (Taylor, 1913) and New Zealand (Miller, 1922) along with imported cattle. In Africa it has been recorded from Somaliland, Abyssinia, Kenya Colony (Neumann, 1912), Tanganyika territory (Neumann, 1912), Nyasaland (Old, 1909), Mozambique, Egypt, Sudan (King, 1908), Belgian Congo (Nuttall, 1916), S. W. Africa—Walfisch Bay—, Transvaal, Orange Free State, Natal, Cape of Good Hope Colony, Tripoli, Sahara, Tunis, Algeria, Morocco, Tangier, Nigeria (Simpson, 1912), Gold Coast (Simpson, 1914), Senegal and the Island of Teneriffe. In Europe it has been reported from Astrakhan, Caucausia, Kherson, Tschernomorsk (Yakimoff, Kohl—Yakimoff, 1911), Don, Crimea (Yakimoff, 1922), Mytilene (Senevet, 1920), Sporades, Castellos in the Island of Rhodes, Crete, Rumania, Greece, Hungary (Kotlán, 1921), Dalmatia, Herzegovinia, Italy, Sicily, Sardinia, Southern France, Spain and Portugal. In America it has been once recorded from Guadeloupe (Anonymous, 1914) in the West Indies, where it has been imported along with cattle. In India it is one of the commonest of cattle

ticks. In the Punjab, Sindh, Rajputana and the United Provinces it is the only cattle tick, but in Bihar and Orissa, the Central Provinces and in the Madras and Bombay Presidencies it is very commonly found on domestic animals along with *B. australis*. It is very rare in the Bengal Presidency and in Ceylon where it has been imported from the adjoining provinces. It is apparently not found in Assam, Burma and other countries beyond Burma.

The following five lots, in addition to the several hundreds of lots which I have examined from India proper, are from Seistan and the Perso-Baluchistan Frontier where the species is common.

Labi Baring (♀, at the base of Tamarisk bushes), Nasaratabad, (♀, from an unknown host), between Nasaratabad and Chilling (♀, from an unknown host) and (♀s, from an unknown host) in Seistan. Saindak (♀, from an unknown host) on Perso-Baluchistan Frontier.

In India the species generally attacks cattle, horse, camel, goat, donkey, dog (occasionally) and bear (occasionally). The following records show that the nymphs also attack the hedgehog :—

Karachi (two lots of Os, off *Erinaceus pictus* Stoliczka, and Os, off *E. collaris* Gray and Hardwicke) and Kotri (Os, off *E. collaris*), both in the Karachi Dist. Rohri in the Sukkur Dist. (Os, off *E. collaris*). Rajanpur in the Dera Ghazi Khan Dist. (O, off *E. jerdoni* Anderson).

Subsp. **dromedarii** Koch.

1844. *Hyalomma dromedarii*, Koch, *Arch. Naturgesch.* X (Bd. I), p. 220.
1847. *Hyalomma dromedarii*, Koch, *Übersicht des Arachnidensystems* Heft 4, pp. 33, 34, pl. ii, figs. 6, 7 (Nürnberg).
1901. *Hyalomma aegyptium* var. *dromedarii*, Neumann, *Mém. Soc. Zool. France* XIV, p. 313.
1911. *Hyalomma aegyptium dromedarii*, Neumann, *Das Tierreich* XXVI, p. 51.
1913. *Hyalomma aegyptium* var. *dromedarii*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 610 (Madras).
1922. *Hyalomma aegyptium dromedarii*, Senevet, *Arch. Inst. Pasteur Afriq. Nord* II, pp. 412, 413.
1924. *Hyalomma dromedarii*, Chodziesner, *Zool. Jahrbücher* (Syst. Abt.) XLVII, pp. 555—557, figs. S, W, L^1, M^1, N^1, O^1.

Male.—Schulze [1] and Chodziesner regard this subspecies as a species separate from *Hyalomma* (*Hyalomma*) *aegyptium*, and differentiate the male from the males of other species by its flat body, larger size, comparatively short palps and by the presence of an inner projection in the middle of the adanal shield. The last character, as already pointed out by me, has little specific value, since there are male individuals in the typical subspecies also possessing these projections on the adanal shields. The two principal characters given by Neumann to differentiate this subspecies from the typical subspecies are the inner projections of the adanal shields and the white median festoon (parma) : both these characters are present in certain male individuals of the typical subspecies. I

[1] Schulze in his key gives the following distinguishing characters of this subspecies "Innerer Vorsprung der Analplatten in eine feine Spitze auslaufend. Sehr grosse (6·5×4 mm.) platte Art mit kurzen Palpen." [*vide, Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1919, p. 194 (1919)].

differentiate the male of this subspecies from that of the typical subspecies by the following characters :—

Last three pairs of legs with segments much stronger than those of the first pair ; palps short with lateral projection on article III and blunt dorsal retroverted prominence on article II ; scutum less chitinous.

In addition to Chodziesner's description of this subspecies the following points may be noted. All the dorsal grooves of the male are shallow. The cervical grooves are broad, divergent posteriorly and are continuous with the postero-lateral grooves. The median groove is narrow and superficial and is continuous in some cases with an ill-defined groove between the cervical grooves. The lateral grooves are poorly developed and their anterior portions are hardly visible, as in the typical subspecies. Of the eleven festoons only five have grooves on the scutum. The white parma is well developed. Six to eight scutes are present, though sometimes they are poorly developed. The lateral extensions of the body beyond the scutum are considerably developed and they make the body as broad as long. The following are the measurements of the largest and the smallest male from Dera Ghazi Khan :—

Length.					Breadth.
4·5 mm.	..	..	..	..	4·2 mm.
5·7 mm.	..	..	..	..	5·7 mm.

The capitulum is 1·3 mm. in length. The palps are two and a half times as long as broad. The retroverted prominence on article II is much more blunt than in the typical subspecies and the proximal portion of this article is not so narrow as in the latter. Articles II and III are sub-equal and both of them are as broad as long.

The female is difficult to differentiate from the typical subspecies and is not represented in the Indian Museum collection.

Distribution and hosts.—This subspecies has previously been recorded from Nubia, Egypt, Sudan, Tripoli, Algeria and Morocco (Lavier, 1923) in Africa and Russian Turkestan (Yakimoff, 1917)—Tashkent and Bokhara—, Transcaspian, Asia Minor and Syria in Asia.

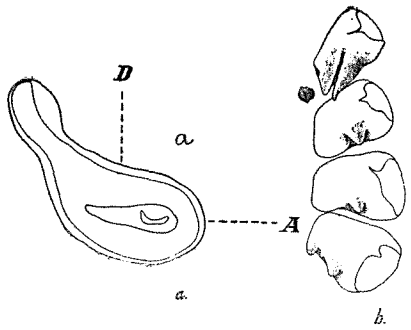
The following new records show that the range of this subspecies has extended up to the Punjab. There are in the Indian Museum collection a single male from Sufean Lahej, Aden and a few other males, off *Erinaceus megalotis* Blyth from Afghanistan, Karachi in Sindh (♂s, off *Mabuia* sp.) and Dera Ghazi Khan in the Punjab (♂s, host unknown). The chief host of this subspecies is the camel and the two hosts here given, *viz.* the lizard and the hedghog, are not the normal host and it is probably by chance that these ticks have attacked them.

Subsp. **isaaci**, nov.

(Plate IX, fig. 2).

Male.—The size varies from 3·5×2·4 mm. to 4·5×3·5 mm. The scutum is Hessian brown to bone brown in colour and is highly chitinised. The surface of the scutum has many longitudinal grooves which give its surface a roughened appearance. The posterior margin of the scutum is almost straight. The lateral grooves are well developed, broad and shallow and contain many punctations ; they start a little

behind the eyes and terminate above the spiracles. The cervical grooves closely resemble those of the subsp. *aegyptium* but are broader and shallower. The median groove is long and narrow and bifurcates posteriorly to enclose a parma. Anteriorly in some cases the scutum exhibits a long oval depression between the cervical grooves as in the subspecies *aegyptium*. On either side of the median groove there is a short groove which bifurcates posteriorly to enclose the fourth festoon of the side. External again to these are the postero-lateral grooves which are continuous with the cervical grooves. Internal to the postero-lateral grooves there are two anteriorly diverging grooves. There are eleven distinct festoons but only five or seven of the median ones present separate grooves on the scutum. There are eleven well-developed brown scutes. The punctations are markedly unequal. The smaller ones are much more numerous, and are closer set than in the subsp. *aegyptium*. The larger ones are few and are sparsely scattered all over the scutum, but they are more numerous on the scapular regions and along the margins. The ventral shields are strongly developed, and the adanal shields are comparatively longer than those in the subsp. *aegyptium ;* they are never produced into internal processes. The spiracle is comma-shaped with the head portion somewhat longer than the tail. The legs are strong, chocolate in colour with yellowish spots on the external surfaces of the joints. The coxal armature is as in the subsp. *aegyptium*, but is better developed.



TEXT-FIG. 36.—*Hyalomma* (*Hyalomma*) *aegyptium* subsp. *isaaci* ♂ : (*a*) spiracle, × 34 ; (*b*) coxal armature, × 16.

The capitulum resembles that of the subsp. *aegyptium* but on the average is much stronger.

Female.—The scutum is of a bone-brown colour. It is longer than broad. The size varies from 1·9×1·8 mm. to 2·4×2·2 mm. The lateral grooves are better indicated than in the subsp. *aegyptium*. The punctations are markedly unequal : the larger ones are very few in the greater posterior portion of the median field but are numerous on the scapular regions. The finer ones are numerous throughout. The spiracle is as in the subsp. *aegyptium*. The legs are of a chocolate colour with distinct and sharply defined, narrow, yellowish rings at the joints.

The capitulum is stronger than that in the male and is 1·1—1·3 mm. in length. The porose areas are larger than in the subsp. *aegyptium*

and are sub-circular in shape with the interval between them equal to one-half the diameter.

This subspecies is comparatively larger in size than the subsp. *aegyptium* and can easily be distinguished from it by the dark glossy colouration of its legs and scutum. It is closely related to *Hyalomma* (*Hyalomma*) *aegyptium* subsp. *impressum* Koch from which, however, it differs in having comparatively narrow yellowish rings on the joints of the legs. The male of subsp. *isaaci* differs from that of subsp. *impressum* in having a comma-shaped spiracle and comparatively better developed lateral grooves.

I name this subspecies after my friend Mr. P. V. Isaac, Second Entomologist to the Government of India. The type-specimens (Reg. No. $\frac{60}{18}$) from Kandeli, Hoshangabad District in the Central Provinces, host buffalo, are in the Indian Museum.

Distribution and hosts.—

Nepal.—Kota (♀, off *Cervus affinis*).

Bihar and Orissa Province.—Bankipore in the Patna Dist. (♂s ♀s, off dog). Kochas (♂s, off sheep) and Nawanagar (♀, off bullock and ♂, off buffalo), both in the Shahabad Dist. Nawada in the Gaya Dist. (♂s, off bullock). Monghyr (♂s, off goat and ♂, off buffalo). Chatra in the Hazaribagh Dist. (♀s, off sheep, ♂s ♀, off cow, ♂s, off mare, ♂, off bullock and ♂s ♀s, off calf). Daltonganj in the Palamau Dist. (♂s ♀, off cow). Simdega in the Ranchi Dist. (♂, off dog). Purulia in the Manbhum Dist. (♂, off buffalo). Chaibassa in the Singhbhum Dist. (♂s ♀, off buffalo). Sambalpur (♀s, off buffalo) and Bargarh (♀s ♂s, off buffalo), both in the Sambalpur Dist. Balasore (♀s, off cow). Angul (♂ ♀s, off buffalo and ♂s ♀s, off dog), Jonda village (♂s ♀s, off buffalo, and ♂s ♀s, off bullock), Phulbani (♂s ♀s, off goat and ♂s ♀s, off cattle) and Angul Agricultural Farm (♂s ♀s, off buffalo), all in the Angul Dist.

United Provinces.—Mawal in the Bara-Banki Dist. (♀s, host unknown.) Babugarh in the Meerut Dist. (♂, host unknown, Muktesar Coll.).

Central Provinces.—Chitral (♂s ♀s, off buffalo and ♂s, off sheep), Saugor (♀, off dog) and Dhana camp (♂s, off cattle), all in the Saugor Dist. Hoshangabad (♂, off pony) and Kandeli (♂s ♀s, off goat and ♂s ♀, off bullock), both in the Hoshangabad Dist. Harsud in the Nimar Dist. (♂s, off cow). Betul Town (♂, off horse, ♀, off goat and ♂ ♀, off dog). Jainpur in the Khandwa Dist. (♂s ♀s, off bullock). Seoni Town (♂, off bullock). Binjori in the Mandla Dist. (♂s, off cow and buffalo). Bilaspur Town (♂s, off cow). Katol in the Nagpur Dist. (♂, off cattle). Sakoli (♂, off heifer) and Malda Village (♂ ♀, off calf), both in the Bhandara Dist. Autergaon, Hinanghat Tehsil in the Wardha Dist. (♀, host unknown). Jambusar (♂s ♀, off buffalo, ♂s ♀, off sheep, ♂s ♀, off camel and ♂, off goat). Baskware (♂s, off mare). Daryapur in the Amraoti Dist. (♂s, off horse). Basim (♂, off horse and ♂s, off dog) and Patur (♂ ♀, off calf and ♂, off buffalo), both in the Akola Dist. Pusad (♂, off pony), Darwha (♂, off pony), Pandharkawada (♂ ♀s, off buffalo), Chimchala (♂s ♀, off bullock) and Umerkhed (♂ ♀, off bullock), all in the Yeotmal Dist.

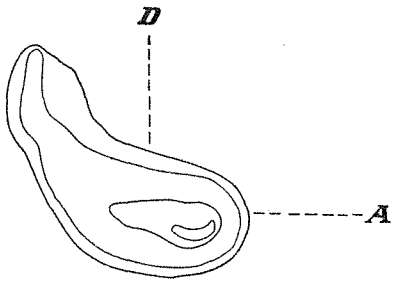
Madras Presidency.—Madanapalle in the Chittoor Dist. (♂s, off bullock). Bangalore in the Mysore State (♀, on grass).

Punjab.—Dera Ghazi Khan (♀, off cattle). Sohawa in the Jhelum Dist. (♂s ♀, off camel).

Bombay Presidency.—Kumta in the N. Kanara Dist. (♂s ♀s, off buffalo).

Subsp. **ferozedini,** nov.

Male.—The size of the male is 4·0×2·9 mm. The scutum is smooth and of a bone-brown colour. The punctations are of two kinds: the larger are few and sparsely scattered over the major part of the body but are more numerous on the caudal field and on the scapular regions; the finer punctations which are present all over the scutum are hardly visible. The lateral grooves are long and narrow; they start a little behind the eyes and end above the spiracles. The other grooves resemble those in the subsp. *isaaci* but are more shallow. The parma is whitish in colour. There are eleven festoons with eleven scutes but the grooves of the seven median ones only extend on to the scutum.



TEXT-FIG. 37.—*Hyalomma* (*Hyalomma*) *aegyptium* subsp. *ferozedini* ♂ : spiracle, ×55.

The venter is yellowish white. The coxal armature is as in subsp. *isaaci*. The leg segments are of a deep brown colour with longitudinal and sharply defined whitish streaks on the external surface of all the four legs. The ventral shields which are well developed, are of a deep brown colour. The adanal shields have no spines on the inner edge. The spiracle is comma-shaped with the head portion twice as long as the tail.

The capitulum is 0·96 mm. in length. The dorsal ridge is strongly curved towards the anterior, especially in the middle, otherwise it is as in the typical subspecies.

Female.—The size of the scutum is 2·1×2·1 mm. The colour is bone-brown with a light brown streak along the antero-lateral margins. The eyes are yellow. The punctations are as in the subspecies *isaaci* but the finer ones are less numerous. All the four legs have whitish longitudinal streaks, as in the male.

This subspecies bears a superficial resemblance to *Hyalomma detritum* subsp. *albipictum* Schulze in having longitudinal white streaks on the legs but differs from it in having a comma-shaped spiracle in the male.

I have much pleasure in naming this subspecies after my friend Mr. Feroze Din Murad of the Aligarh Muslim University. The type-specimens

(Reg. No. $\frac{61}{18}$, 3 ♂s ♀, off cattle from Sasaram in the Shahabad District) are in the Indian Museum.

Distribution and hosts.—**Bihar and Orissa Provinces.**—Sasaram in the Shahabad Dist. (♂, off pony). Chatra in the Hazaribagh Dist. (♂, off cow). Porahat in the Singbhum Dist. (♂♀s, off buffalo).

Hyalomma (Hyalomma) syriacum Koch.

1804. *Cynorhaestes aegyptius*, Hermann, *Mémoire Aptérologique* An. XII, p. 66, pl. iv, figs. 9 and 1, pl. vi, fig. 13 (Strasbourg).
1844. *Hyalomma syriacum*, Koch, *Arch. Naturgesch.* X (Bd. 1), p. 222.
1847. *Hyalomma syriacum*, Koch, *Übersicht des Arachnidensystem* Heft 4, p. 44, pl. vi, fig. 21 (Nürnberg).
1855. ? *Ixodes testudinis*, Leydig, *Arch. Anat. Physiol. Wiss. Med.* Jahrg. 1855, p. 382, pl. xv, fig. 5.
1873. ? *Ixodes aegyptius*, Lucas, *Ann. Soc. Entom. France* (5) III *Bull.* p. xxxii.
1899. *Hyalomma affine*, Neumann, *Mém. Soc. Zool. France* XII, pp. 291-293, text-fig. 61.
1901. *Hyalomma syriacum*, *id.*, *ibid.* XIV, p. 315.
1906. *Hyalomma syriacum*, Wheler, *Journ. Agric. Sci.* I, pp. 419, 420, pl. vii, fig. 12.
1908. *Hyalomma syriacum*, Bonnet, *Arch. Parasitol.* XII, p. 259, text-figs. 26, 27.
1911. *Hyalomma syriacum*, Neumann, *Das Tierreich* XXVI, p. 52, text-fig. 28.
1924. *Hyalomma syriacum*, Chodziesner, *Zool. Jahrbücher* (Abt. Syst.) XLVII, pp. 544, 545, text-figs. P, T, A.[1]

Male.—The colour of the scutum varies from Hessian-brown to bone-brown. The cervical grooves are only represented by short oval slightly converging deep depressions. Other dorsal grooves are absent. The punctations are of two kinds: the larger are very few in number and are sparsely scattered; they are interspersed with numerous close-set and very fine punctations.[1] The eleven festoons have distinct grooves on the scutum. The suctes are absent.

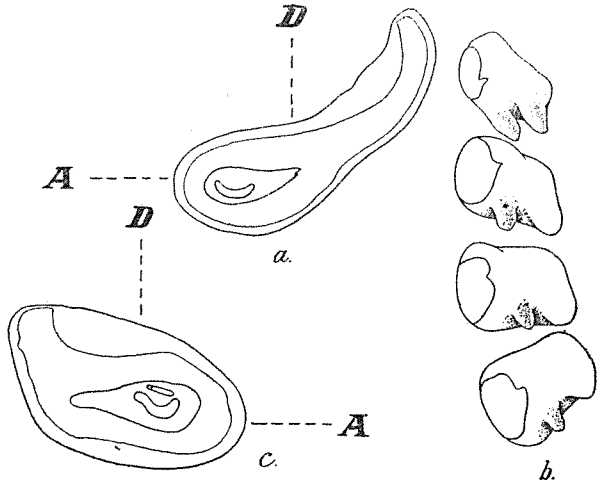
The following are the measurements of males from different places :—

		Length	Breadth
Reg. No. $\frac{1172}{17}$ ..	Banias, Mt. Hermon (Palestine)		
	Smallest ♂	4·2 mm.	2·8 mm.
	Largest ♂	4·9 mm.	3·4 mm.
Reg. No. $\frac{956}{17}$ ..	Quetta	4·9 mm.	3·4 mm.
Reg. No. $\frac{1173}{17}$ ..	Jugdulluk (Afghanistan) ..	4·9 mm.	3·4 mm.

The adanal shields are slightly longer than broad with the posterior margin longer than the internal. The sub-anal shields, though present, are poorly developed. The spiracle is retort-shaped with the posterior portion of the dorsal margin much thickened. Coxa I has two equal and well-separated spurs. The spurs on the other coxae resemble those of *H.* (*H.*) *aegyptium* but are better developed than in that species. The leg segments are deep brown in colour with narrow yellowish-white rings at the distal end of each segment. Tarsus IV is as in *H.* (*H.*) *aegyptium* but with stronger tarsal spurs.

[1] In none of the previous descriptions of this species are the finer punctations mentioned. They generally become more conspicuous after rubbing the scutum with a piece of cloth.

The capitulum is 1·3 mm. in length. The base is rectangular with the lateral sides somewhat convex externally. It is less than twice as broad as long. The cornua are short, broad and blunt. Article II is very narrow proximally and is triangular in shape when viewed from the dorsal



Text-fig. 38.—*Hyalomma* (*Hyalomma*) *syriacum* : (*a*) ♂, spiracle, × 51 ; (*b*) ♂, coxal armature, × 23 ; (*c*) ♀, spiracle, × 51.

side ; its retroverted prominence on the dorsal side is well developed. Article III has a slight external salience at the posterior end. The hypostome has 3|3 rows of teeth with about seven teeth in each row along with many scale-like teeth in the posterior portion. In other respects the capitulum resembles that of *H.* (*H.*) *aegyptium.*

Female.—The scutum is sub-hexagonal with the postero-lateral sides somewhat cancave and the antero-lateral sides convex, while the posterior margin is regularly curved. The larger punctations are rare on the median field but are more numerous on the lateral fields. The finer ones are numerous but are visible only on close examination. The following are the measurements of the scutum of the females in the Indian Museum Collection :—

		Length	Breadth
Reg. No. $\frac{1172}{17}$ ..	Banias, Mt. Hermon (Palestine) ..	2·0 mm. 2·8 mm.	2·2 mm. 2·4 mm.
Reg. No. $\frac{956}{17}$ ..	Quetta (Baluchistan) ..	2·4 mm. 2·5 mm.	2·4 mm. 2·5 mm.

The spiracle is elongate-oval in shape with the posterior side straight ; the dorsal protuberance is not so prominent as in *H.* (*H.*) *aegyptium.* The coxal armature and the colour of the leg segments are as in the male. Tarsus IV and the foot are as in the female of *H.* (*H.*) *aegyptium.*

The capitulum is 1·4 mm. in length. The base is twice as broad as long with obsolete cornua. It has lateral saliences on the base that are less pronounced than those in *H.* (*H.*) *aegyptium.* The hypostome has 3|3 rows of teeth that are comparatively stronger than those in the male ; in other respects it resembles that of *H.* (*H.*) *aegyptium.*

Distribution and hosts.—The species has been recorded by previous workers from Russian Turkestan—Samarkand—(Yakimoff, 1917), Asia Minor and Syria in Asia, from Caucasia, Rumania, Greece, the Island of Mytilene (Senevet, 1920) and Feltham in Surrey, England,[1] in Europe and from Egypt, Sudan (Neumann, 1902), Tripoli, Tunis, Algeria, Senegal, Congo and Cape of Good Hope in Africa. According to Schulze, however, the specimens from Southern Africa are those of *Amblyomma sylvaticum*.[2] If this conclusion is correct then the species is confined to the Mediterranean sub-region and the adjoining countries. The new records extend its distribution up to Baluchistan.

Baluchistan.—Quetta (♂s ♀s, off a land tortoise).
Afghanistan.—Jugdulluk (♂, off *Testudo horsfieldii* Gray).
Palestine.—Banias, Mt. Hermon (2 lots of ♂s ♀s, off *Testudo ibera*).

Subgenus **Hyalommina** Schulze.

1901. *Hyalomma* (*en partim*), Neumann, *Mém. Soc. Zool. France* XIV, pp. 317, 318.
1919. *Hyalomma* (*Hyalommina*), Schulze, *Sitzungsb. Ges. Naturf. Freunde Berlin*, Jahrg. 1919, p. 192.
1924. *Hyalomma* (*Hyalommina*), Chodziesner, *Zool. Jahrbücher* (Abt. Syst.) XLVII, pp. 543, 544.

In 1919 Schulze created the subgenus *Hyalommina* to include *Hyalomma rhipicephaloides* Neumann. He differntiates this subgenus from the subgenus *Hyalomma* by the absence of the sub-anal shields and by the presence of humps on tarsi II-IV. A detailed study of the two new Indian species of this subgenus described below enables me to discuss fully the systematic position of these two subgenera *Hyalomma* and *Hyalommina*.

The subgenus *Hyalommina* shows considerable resemblances to *Rhipicephalus* Koch and, as Neumann[3] pointed out, *H. rhipicephaloides* is intermediate between the genera *Rhipicephalus* and *Hyalomma*. The outline of the basis capituli when viewed from the dorsal aspect in the species of a genus of the family Ixodidae, as a rule, possesses the same form. In the subgenus *Hyalommina* the basis capituli is a broad hexagon in both the males and females. In the subgenus *Hyalomma* it is rectangular in the male and sub-triangular in the female. *Hyalommina*, as regards the outline of the base, is intermediate between *Hyalomma* and *Rhipicephalus* but resembles the latter more closely. The existence of an intermediate subgenus between *Rhipicephalus* and *Hyalomma* points to their close relationship and I am unable to agree with Nuttall and Warburton [4] in regarding *Hyalomma* as more closely related to *Amblyomma* than to *Rhipicephalus*.

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[1] The occurrence of this species in England is accidental *vide*, Pocock, *Zoologist* (4) IV, p. 327 (1900).

[2] *Amblyomma sylvaticm* (de Geer) is synonymous with *Amblyomma latum* (Koch) *vide* Robinson, *Ticks* II (part 4), p. 151 (Cambridge, 1926).

[3] "Cette espèce (*H. rhipicephaloides*),.....est intermédiaire á *Rhipicephalus* et *Hyalomma*. Elle a des premiers le facies général et la forme des pattes ; elle se rattache aux seconds par le rostre, qui est, d'ailleurs, court et rappelle encore les *Rhipicephalus*." See Neumann, *loc. cit.*, p. 318 (1901).

[4] Nuttall and Warburton, *Ticks* part 2, pp. 112, 113 (Cambridge, 1911).

I distinguish *Hyalommina* from *Hyalomma* by the following characters :—

Sub-anal shields absent ; tarsi humped ; basis capituli broad hexagonal with lateral saliences in both male and female strongly developed, especially in the latter ; individuals comparatively small and inornate ; spiracle comma-shaped or elongate-oval in the male.

The two Indian species are very closely related to each other and only differ in a number of minor points. *H.* (*Hyalommina*) *hussaini* var. *brevipunctata*, nov. brings the two species still closer, but I am convinced that *H.* (*Hyalommina*) *kumari*, sp. nov. is distinct from it.

Key to the Indian species of the subgenus *Hyalommina*.

Males.

I. Scutum, legs, capitulum and ventral shields claret-brown or Victoria-lake in colour ; lateral grooves deep and well developed ; tarsus IV comparatively less humped.	
A. Punctations large, few in number and sparsely scattered ; dorsal grooves on the scutum comparatively well developed ; caudal field present ; spiracle elongate-oval	*hussaini.*
B. Punctations fine, numerous, densely scattered on the periphery ; dorsal grooves rather poorly developed ; caudal field absent ; spiracle comma-shaped	*hussaini* var. *brevipunctata.*
II. Scutum, legs, capitulum and ventral shields sayal-brown in colour ; lateral grooves poorly developed, sometimes absent, tarsus IV strongly humped ..	*kumari.*

Females.

I. Scutum, legs and capitulum claret-brown in colour ; tarsus IV comparatively less humped.	
A. Punctations large, very few in the median field ; lateral grooves well defined ..	*hussaini.*
B. Punctations fine, numerous and close-set, especially in the median field ; lateral grooves poorly developed	*hussaini* var. *brevipunctata.*
II. Scutum, legs and capitulum Sanford's-brown in colour ; tarsus IV strongly humped	*kumari.*

Hyalomma (Hyalommina) hussaini, sp. nov.

(Plate IX, figs. 3, 4).

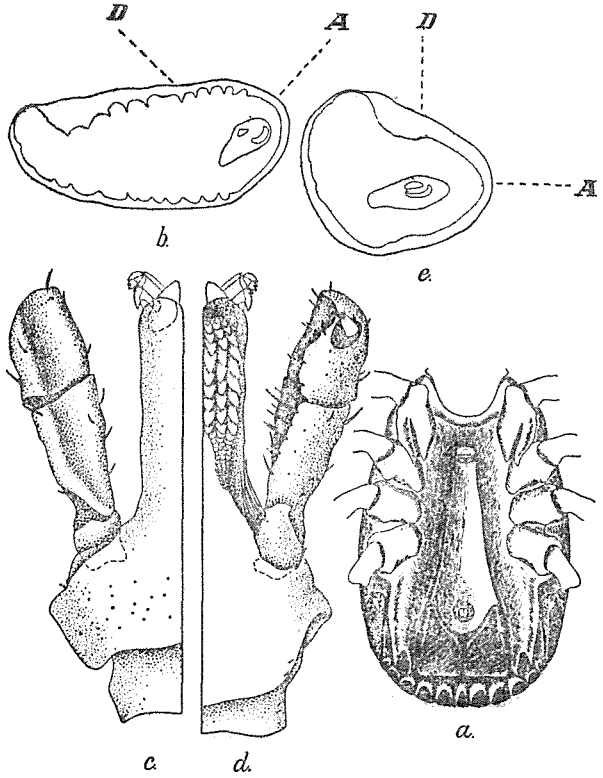
Of this species I have found two forms : the *forma typica* and var. *brevipunctata.*

Forma typica.

Male.—The body is elongate-oval in shape, being broadest in front of the spiracle. It varies in size from 2·2 ×1·6 mm. to 2·9×1·9 mm. The scutum varies from claret-brown to Victoria-lake in colour. It is slightly constricted opposite the spiracle. The cervical grooves are represented by short converging and deep oval depressions which are continued posteriorly into superficial broad and diverging grooves. The punctations are large and equal ; they are few in number and are

sparsely scattered all over the scutum but are somewhat more numerous on the scapular regions. The lateral grooves are well developed and deep ; starting a little behind the eyes, each includes posteriorly two festoons. There is on the hinder lesser half of the scutum a somewhat ill-defined sub-triangular depression containing the posterior three grooves. The postero-median groove is short and narrow, occupying the posterior third of the scutum. It bifurcates posteriorly to enclose the median festoon. The postero-lateral grooves are shorter and broader than the median groove and have ill defined and externally concave depressions, which are generally continuous with the cervical grooves in front of them. The eyes are spherical in outline and orbital. The eleven festoons have distinct grooves on the scutum and scutes on the ventral side, but the scutes in connection with the median and external festoons are somewhat poorly developed.

The venter is generally whitish in colour. The ventral shields are punctate and are of a claret-brown colour. The adanal shield is one and a half times as long as broad and the posterior margin is one and a half times as long as the internal margin. The accessory shields are small and



TEXT-FIG. 39.—*Hyalomma (Hyalommina) hussaini* : (*a*) ♂, venter, × 14 ; (*b*) ♂, spiracle, × 55 ; (*c*) ♂, capitulum, dorsal aspect, × 55 ; (*d*) ♂, capitulum, ventral aspect, × 55 ; (*e*) ♀, spiracle, × 55.

sub-oval. The sub-anal shields are absent. The spiracle is elongate-oval, with a short macula ; it is about twice as long as broad. The legs

are claret-brown in colour without any trace of ornamentation. The coxal armature is as in *H.* (*Hyalomma*) *aegyptium*, but differs from that species in having an obsolete broad internal spur on coxa IV similar to that on the other coxae ; there is no projection on the inner spur of coxa I. Tarsus IV is humped prior to tapering into two well separated strong ventral spurs. The distal portion of tarsus IV is one and a half times as long as the proximal. The pad attains less than half the length of the claws.

The capitulum is one and a half times as long as broad ; it is 0·78—0·92 mm. in length. The base is a broad hexagon in shape with the lateral saliences situated about the middle of its length ; it is twice as broad as long. The cornua are short and blunt. The palps are about three times as long as broad, and are club-shaped. They have an elonggated depression on the dorsal surface and a whitish spot at the junction of articles II and III on the supra-internal side. The distal half of article I is visible on the dorsal aspect and this article bears a ventral plate usually bearing four long simple hairs. Article II is longer than article III. Its proximal portion is narrow and the article gradually broadens in the distal half. It has a retroverted raised prominence on the dorsal side. It usually bears four short hairs on the supra-internal margin and six comparatively long hairs on the infra-internal margin. Article III is sub-quadrangular and is longer than broad. The hypostome has 3|3 rows of teeth with about ten strong teeth in each row followed by scale-like teeth. The dorsal process is biscuspid. The external cheliceral article has two very closely-placed cusps, the distal being very small and sub-ventral in position.

Female.—The unfed female is chestnut-brown in colour and is 3·1 × 2·2 mm. The scutum is sub-cordiform and slightly longer than broad and measures 1·33 × 1·25 mm.—1·9 × 1·7 mm. ; it is claret-brown in colour. The eyes are spherical and orbital. The emargination is deep. The cervical grooves are at first deep and strongly convergent ; they then become shallow and divergent, and finally reach the posterior margin. The lateral grooves are formed of large punctations and together with the cervical grooves enclose sub-oval cervical fields which are comparatively free from punctations. The larger punctations are sub-equal and sparsely scattered, but are more numerous on the scapular regions. The finer punctations cannot as a rule be detected but when seen they are found to be rather few in number on the median and the cervical fields. The posterior grooves on the general body are as in *H.* (*Hyalomma*) *aegyptium*. The spiracle is sub-triangular and is almost as long as broad. The porous area is short and comma-shaped with a broad tail. The legs are as in the male except that the segments are longer and are more slender. Tarsus IV possesses a hump and tapers into two blunt ventral spurs, one of which is large and the other rather small.

The capitulum is comparatively stronger than that of the male and is 1·05—1·08 mm. in length. The base is three times as broad as long. The cornua are obsolete but the lateral saliences are much more prominent than those in the male. The porose areas are short and oval, and the interval between them is equal to their larger diameter and there is a keel-shaped ridge between them. The palps are four times as long as

broad. The external cheliceral article has three cusps, the distal being very close to the middle one and sub-ventral in position. The dorsal process is crescent-shaped.

The largest replete female in the collection is 11·0×6·0 mm. in size.

The species differs considerably from the only known species *H.* (*Hyalommina*) *rhipicephaloides* Neumann in having well developed broad ventral shields and lateral grooves in the male.

I have great pleasure in associating this species with the name of Mr. M. A. Hussain, Entomologist to the Government of the Punjab. The type-specimens (Reg. No. $\frac{57}{18}$) are from a bullock at Akola Town in the Central Provinces and are in the Indian Museum.

Distribution and hosts—

Bihar and Orissa.—Chapra (♂s ♀s, off buffalo) and Semaria (♂s ♀, off bullock), both in the Saran Dist. Arrah (♀s, off buffalo), Sasaram (♂s ♀s, off cattle and ♂s ♀s, off dog), Nokha (♂s ♀s, off bear), Kochas (♂s ♀, off Nilgai) and Ramgarh (♂s ♀s, off cow), all in the Shahabad Dist. Kolyampur (♂s, off cattle) and Monghyr Town (♂s ♀s, off buffalo), both in the Monghyr Dist. Gaya Town (♂s ♀s, off cattle), Nawada (♂s ♀s, off buffalo and cow), Warisaliganj (♂s ♀, off buffalo and ♀, off bullock), Aurangabad (♂, off buffalo and ♂ ♀, off horse), Tikari village (♂s ♀s, off buffalo) and Jahanabad (♂s ♀s, off buffalo, ♂s ♀s, off mare and ♂, off goat), all in the Gaya Dist. Garhwa in the Palamau Dist. (♀s, off cow). Chatra (♂, off buffalo) and Kodarma (♀s, off dog), both in the Hazaribagh Dist. Chaibassa in the Singhbhum Dist (♀s, off buffalo). Barahpur (♂s ♀s, off buffalo and ♀, off bullock). Jonda village in the Angul Dist. (♀, off buffalo). Puri (♀, off cow).

Central Provinces.—Dhana camp (♂s ♀, off cattle), Chitra (♀s, off dog and ♂ ♀s, off cattle) and Saugor (♀, off cattle), all in the Saugor Dist. Hoshangabad Town (♀, off pony). Seoni Town (♂s ♀s, off bullock and ♂s ♀s, off buffalo). Betul Town (♂s ♀s, off dog and ♂ ♀s, off bullock). Harsud in the Nimar Dist. (♂s ♀s, off bullock). Bilaspur Town (♂s ♀s, off cow and bullock). Bhandara (♀, off goat and ♀s, off pony) and Sakoli (♀, off cow), both in the Bhandara Dist. Katol in the Nagpur Dist. (♂s ♀, off cattle). Drug Town (♀, off bullock). Jainpur village in the Khandwa Dist. (♂s ♀, off bullock). Autergaon village in the Wardha Dist. (♂s ♀s, off cattle). Rowabanda (♂s ♀s, off bullock and ♂ ♀, off buffalo). Baskware (♂s ♀s, off mare). Lawala (♀, off bullock). Jambusar (♂s off bullock and ♂ ♀s, off camel). Jamal Government farm (♂, off heiler). Amraoti Town (♂s ♀s, off bullock), Daryapur (♂s ♀s, off horse), Kamanapur (♀s, off bullock), Mangrul-Dastgir (♂s ♀s, off bullock) and Ellichpur (♂s ♀s, off cow), all in the Amraoti Dist. Balapur Town (♂s ♀s, off bullock), Akot (♂s ♀s, off bullock), Basim (♂, off buffalo), Patur (♀s, off cow) and Rambnapur near Murtazapur (♂s ♀s, off bullock), all in the Akola Dist. Malkapur (♂s ♀, off dog), Duralsched Village (♂, host unknown), Mehkar (♀, off buffalo, ♂ ♀, off cow and ♀s,

off dog), Buldana Town (♀, off bullock), Jalgaon (♀s, off buffalo and ♂, off pony) and Shegaon (♂s ♀s, off goat), all in the Buldana Dist. Darwha (♂s ♀s, off pony, ♂s ♀, off goat and ♂s ♀s, off buffalo), Pandharkawada (♂s, off bullock and ♂s ♀, off buffalo), Umerkhed (♂s ♀s, off buffalo), Yeotmal town (♀, off buffalo, ♀, off bullock and ♂ ♀, off pony) and Chimchala (♀, off bullock), all in the Yeotmal Dist.

Madras Presidency.—Palakol in the Kistna Dist., (♂s ♀s, off buffalo).

Bombay Presidency.—Belgaum (♂s ♀s, off calves).

This species, as the above record shows, confines itself mostly to domestic animals and is, therefore, of economic importance.

Var. **brevipunctata,** nov.

Male.—This differs from that of the *forma typica* in having numerous fine punctations all over the scutum but only a few on the median area. The posterior grooves are more shallow than in the *forma typica* and the posterior sub-triangular caudal field is absent. The lateral grooves do not include any festoon. Its spiracle and capitulum resemble more *H.* (*Hyalommina*) *kumari*, sp. nov. than those of *H.* (*Hyalommina*) *hussaini*.

Female.—The punctations are finer and much more numerous than those in the *forma typica*. They are scattered almost uniformly all over the scutum. The lateral grooves are rather obsolescent. The spiracle is as in *H.* (*Hyalommina*) *kumari*.

This variety appears to be intermediate between *H.* (*Hyalommina*) *kumari* and *H.* (*Hyalommina*) *hussaini*, but is quite distinct.

The type-specimens (Reg. No. $\frac{56}{18}$, ♂ ♀, off dog from Anantapur in the Madras Presidency) are in the Indian Museum.

Distribution and hosts.—This form is not so common as the *forma typica*. It attacks both wild and domestic animals. I have also examined specimens from the following localities :—

Bengal.—Adria jungle in the Midnapur Dist. (♀, off Sambhar, *Cervus unicolor* Bechst., C. S. T. M. Coll. and ♀, off Chital, *Cervus axis* Erxl., C. S. T. M. Coll.).

Bihar and Orissa.—Chatra in the Hazaribagh Dist. (♀, off tiger). Porahat (♀, off dog) and Gohatkuri near Manharpur (♀, off antelope), both in the Singhbhum Dist. Jonda village in the Angul Dist. (♂, off bullock and ♀, host unknown).

Central Provinces.—Chitra in the Saugor Dist. (♀s, off cattle). Malda in the Bhandara Dist. (♀, off bullock and ♂s, off calf). Betul Town (♂, off dog and ♀, off goat). Balaghat (♂, off bullock). Patur in the Akola Dist. (♀, off cow and ♀, off dog).

Madras Presidency.—Madanapalle in the Chittoor Dist. (♀, off bullock).

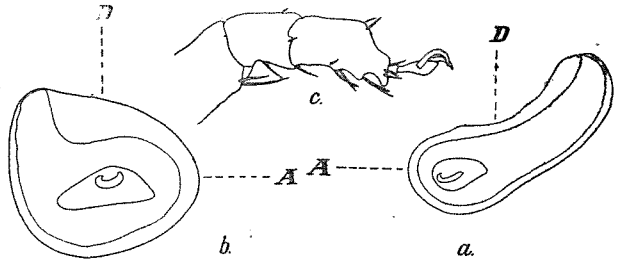
Bombay Presidency.—Belgaum (♂s ♀s, off cattle).

Hyalomma (Hyalommina) kumari, sp. nov.

(Plate IX, fig. 5).

Male.—The body is elongate-oval, being broadest in front of the spiracles. Its size varies from 2·5×1·5mm. to 3·1×2·1 mm. The scutum is slightly constricted opposite the spiracles. In the larger specimens there are lateral projections of the body beyond the scutum. The scutum is of a sayal-brown colour with somewhat darker areas in the neighbourhood of the eyes. The cervical grooves start anteriorly as short, oval, deep and converging depressions which open into shallow diverging grooves. The punctations are fine, sub-equal and numerous. They are dense in the periphery but rather sparsely scattered in the median area. The lateral grooves are generally superficial and poorly developed and they are even absent in some cases. They end over the spiracles and do not include any festoon. There are eleven distinct festoons with somewhat indistinct grooves on the scutum. The corresponding eleven scutes are present but are poorly developed. The postero-median groove is broad and shallow. The postero-lateral grooves are represented by short oval depressions which have long superficial grooves in front of them connecting them with the cervical grooves. The caudal field is either absent or poorly indicated. The eyes are spherical, orbital and of a pale yellow colour. The venter is yellowish white. The ventral shields are as in *H. (Hyalommina) hussaini* but of a sayal-brown colour. The spiracle is comma-shaped with a rather broad tail and is three times as long as broad. The legs are light brown to brown in colour. The coxal armature is as in *H. (Hyalommina) hussaini*. Tarsus IV exhibits a better developed hump than in *H. (Hyalommina) hussaini*.

The capitulum closely resembles that of *H. (Hyalommina) hussaini* but differs from it in the following points. It is 0·78—0·86 mm. in length and is of a sayal-brown colour. The ventral plate on article I usually has two long hairs, and article II has about four short hairs on the supra-internal margin and the same number on the infra-internal. The external cheliceral article has two well-separated cusps.



TEXT-FIG. 40.—*Hyalomma (Hyalommina) kumari* : (*a*) ♂, spiracle, × 55 ; (*b*) ♀, spiracle, × 55 ; (*c*) ♀, tarsus IV, × 35.

Female.—The unfed female is of a brown colour and is 3·2×2·1 mm. The scutum is sub-cordiform and measures from 1·6×1·5 mm. to 1·9×1·6 mm. It is of a Sanford's-brown colour which deepens almost to black in the neighbourhood of the eyes. The cervical grooves are at first deep and convergent ; they then diverge and reach the posterior margin of the

scutum. The lateral grooves are somewhat ill-defined and together with the cervical grooves enclose strongly punctate cervical fields. The punctations are fine, numerous and close-set. The spiracle is sub-triangular and the porous area is comma-shaped with a narrow tail-end. The legs are as in the male but the segments are longer and more slender than in that sex. Tarsus IV is more strongly humped than in the male.

The capitulum is comparatively stronger than in the male. It is 1·1 mm. in length and the base is broader than in the male, while the cornua are obsolete. The porose areas are short oval in shape and the interval between them is raised into keel and is equal to the diameter. The hypostome has 3|3 rows of teeth with about twelve strong teeth in each row. The external cheliceral article bears three cusps, the distal being small and well separated from the middle one.

This species is very closely related to *H.* (*Hyalommina*) *hussaini*, from which it differs in colour, in having poorly developed lateral grooves in the male as well as in many other minor points.

I name this species after Professor Anand Kumar of the Punjab University. The type-specimens (Reg. No. $\frac{2173}{17}$, ♂s ♀s, from *Hemitragus hylocrius* (Ogilby), the wild goat, Parambikulam, alt. 1,700-3,200 ft., Cochin State) are in the Indian Museum.

Distribution and hosts.—This species has a fairly wide distribution in India. It appears to have a special liking for the goat.

Assam.—Nagabera in the Goalpara Dist. (♂, off tiger).

Bihar and Orissa Province.—Hajipur in the Muzaffarpur Dist. (♂s ♀s, off goat). Sewan in the Saran Dist. (♂s ♀s, off goat). Sasaram in the Shahabad Dist. (♂s ♀s, off goat and ♂s ♀, off dog). Jamui in the Monghyr Dist. (♂s ♀, off horse). Nawada (♀, off buffalo), Barawan (♂ ♀s, off goat), and Jahanabad (♂s ♀s, off goat), all in the Gaya Dist. Deogarh in the Sonthal Parganas (♀s, off goat and ♂s ♀, off cow). Puri (♀s, off dog). Larpur (♂ ♀, off goat and sheep).

United Provinces.—Bhowali in the Naini-Tal Dist. (♂s ♀s, off sheep, ♂s, off cattle and ♂, off horse). Aligarh (♂s ♀s, off goat).

Central Provinces.—Mandla (♂s ♀s, off goat).

Punjab.—Kot-Kapura in the Faridkot State (♂s ♀s, off goat and a ♂ found in a mud house). Sialkot (♀, host unknown, Muktesar Coll.).

Genus **Amblyomma** Koch.

1926. *Amblyomma*, Robinson : in Nuttall, Warburton and Robinson's *Ticks : A Monograph of the Ixodoidea*, II (part 4), pp. 9, 10.

This genus is represented in India by seven species of which only two *A. integrum* Karsch and *A. testudinarium* Koch, sometimes attack domestic animals. These, however, are of rare occurrence and hence the genus is of very little economic importance in this country. In all the Indian species of the genus the ventral ridge is obsolete and the posterior strengthening plate of the male genital aperture is present.

Key to the Indian species of the genus *Amblyomma*.

MALES.

I. Marginal grooves present and continuous. ..
- **A.** Coxa I with two short, blunt and sub-equal spurs; scutum pale with very limited dark brown ornamentation; falciform stripe absent; punctations strongly unequal; hypostome 4|4 .. .. .. *clypeolatum.*
- **B.** Coxa I with two strongly unequal spurs; scutum pale with considerable dark brown ornamentation; falciform stripe present; punctation coarse and sub-equal; hypostome 3|3 .. .. .. *integrum.*

II. Marginal grooves absent.
- **A.** Coxae I, II and III each with two sub-equal, short and broad spurs .. .. *supinoi.*
- **B.** Coxa I with two spurs and coxae II-IV each with a single spur.
  - *I.* Scutum inornate; coxa I with two short flat sub-equal spurs.
    - *A.* Hypostome 4|4; coxae II-IV each with a short triangular spur; tarsi taper gradually .. *nitidum.*
    - *B.* Hypostome 3|3; coxae II-IV each with a broad salient ridge-like spur; tarsi taper abruptly .. *sublaeve.*
  - *II.* Scutum ornate; coxa I with two unequal spurs.
    - *A.* Scutum dark brown with six pale coloured spots; falciform stripe absent; hypostome 3|3; coxae II and III each with a short triangular spur .. .. .. *helvolum.*
    - *B.* Scutum yellowish with dark brown ornamentation; falciform stripe present; hypostome 4|4; coxae II and III each with a broad salient ridge-like spur .. *testudinarium.*

FEMALES.

I. Coxae I-III each with two short rounded spurs .. *supinoi.*

II. Coxa I with two short spurs and coxae II-III each with a single spur.
- **A.** Scutum inornate.
  - *I.* Hypostome 4|4; coxae II-IV each with a narrow, triangular spur; tarsi taper gradually .. .. .. *nitidum.*
  - *II.* Hypostome 3|3; coxae II-IV each with a broad salient ridge-like spur; tarsi taper abruptly .. .. *sublaeve.*
- **B.** Scutum ornate.
  - *I.* Coxae II and III each with a narrow triangular spur .. .. *helvolum.*
  - *II.* Coxae II and III each with a broad, salient ridge-like spur.
    - *A.* Hypostome 3|3; coxa I with two unequal spurs .. .. *integrum.*
    - *B.* Hypostome 4|4; coxa I with two sub-equal spurs.
      1. Scutum cordiform, brown, with comparatively less pale ornamentation; coxa I with two short blunt spurs .. *clypeolatum.*
      2. Scutum triangular, brown, with comparatively more extensive pale ornamentation; coxa I with two comparatively stronger spurs .. *testudinarium.*

Amblyomma clypeolatum Neumann.

1926. *Amblyomma clypeolatum*, Robinson, *Ticks* II (part 4), pp. 79-81, text-figs. 34, 35.

Male.—The size of the male specimens in the Indian Museum collection varies from 4·7×4·2 mm. to 5·2×4·7 mm. The dark brown ornamentation of the scutum is rather poorly developed in these specimens; the only clearly marked stripes are the marginals and the postero-median; the postero-accessory and the antero-accessory stripes are indistinct. Besides these there are certain markings of a rusty green colour on the scutum, which vary in number, form and size. The spiracle is longer than broad with a claviform macula half as long as the spiracle. The pad is very short and hardly attains one-fourth the length of the claws.

The capitulum is 1·0 to 1·3 mm. in length. The base is sub-rectangular and is less than twice as broad as long. It is ornate and has obsolete cornua. The palps are three times as long as broad. The ventral plate on article I has one or two long simple hairs. Article II is twice as long as broad, gradually narrowing from the middle towards its proximal end. It usually bears six very short simple hairs on the supra-internal and five comparatively long hairs on the infra-internal margin. Article III is broader than long when viewed from the dorsal side. The depression for article IV occupies one-third of its ventral surface. The hypostome has 4|4 rows of teeth with about nine strong teeth in each row, and these are followed by squamiform teeth arranged in about 7|7 rows. The external cheliceral article has two cusps, the distal being exceedingly small and sub-ventral in position.

Female.—There is only one female in the Molteno Research Institute, Cambridge which I have not been able to examine.

Distribution and hosts.—The species has so far only been recorded off a tortoise in the Budapest Zoological Gardens, and also from India the West Coast of Ceylon. The specimens (♂s, off the armpit of *Testudo elegans* Schoepff) from the last place are in the Indian Museum collection.

Amblyomma integrum Karsch.

1926. *Amblyomma integrum*, Robinson, *Ticks* II (part 4), pp. 111-114, text-figs. 47, 48.

Male.—The cervical grooves are represented by posteriorly converging short oval depressions. Tarsi II-IV taper almost gradually to a strong ventral spur which is preceded by a similar but smaller ventral spur. The pad attains one-third the length of the claws.

The following are the measurements of three males from different places :—

		Length	Breadth
Reg. No. $\frac{2450}{17}$	.. Ceylon	3·5 mm.	3·0 mm.
Reg. No. $\frac{2438}{17}$	.. Mormugao	4·0 mm.	3·25 mm.
Reg. No. $\frac{2170}{17}$	.. Barkul, Puri Dist., Orissa ..	4·5 mm.?	4·0 mm.

The capitulum is 1·6 to 2·0 mm. in length. The base is rectangular and is less than twice as broad as long. Article II of the palp has six simple hairs on the supra-internal and an equal number of hairs on the infra-internal margin. The hypostome has 3|3 rows of teeth with about

TEXT-FIG. 41.—*Amblyomma integrum* ♂: (*a*) coxal armature, × 28; (*b*) tarsus IV, × 34.

seven strong teeth on the distal lesser half, and about 6|6 rows of squamiform teeth on the proximal greater half. The dorsal process is crescent-shaped with strongly developed horns. The external cheliceral article has two cusps, the distal being very small.

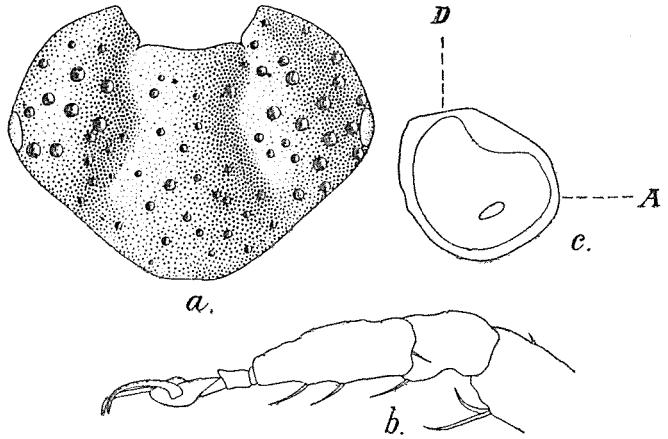
Female.—According to Robinson the cervical stripes do not join the limiting spots but in certain specimens that I have examined the cervical stripes do join them. The eyes are oval and are slightly bulging. The marginal grooves are continuous. The spiracle is longer than broad with a large spoon-shaped macula. The following are the measurements of the scutum of five females from different localities :—

		Length	Breadth
Reg. No. $\frac{64}{18}$	Gopkuda Island, S. Chilka Lake ..	3·1 mm. 2·9 mm.	3·5 mm. 2·9 mm.
Reg. No. $\frac{2451}{17}$	.. Ceylon	2·4 mm.	2·6 mm.
Reg. No. $\frac{2170}{17}$	.. Barkul, Puri Dist., Orissa ..	2·8 mm. 2·8 mm.	2·9 mm. 3·1 mm.

The capitulum is 1·6 to 2·0 mm. in length. The base is twice as broad as long. The porose areas are large and sub-circular, the interval between them being less than their diameter. The external cheliceral article is tricuspid and the dorsal process is crescent shaped.

Nymph.—The scutum is 0·73×1·0 mm. in size and is inornate; it is of a deep brown colour and is cordiform in shape, being broadest about the middle. The antero-lateral sides are convex and are almost equal in length to the postero-lateral sides, which are straight and meet each other posteriorly in a broadly truncated angle. The cervical grooves

are at first deep and convergent but they then become shallow and broad and almost reach the posterior margin. The punctations are comparatively larger than those of the female and are sub-equal in size. Those on the lateral fields are larger than those on the median field.



TEXT-FIG. 42.—*Amblyomma integrum* nymph : (*a*) scutum, × 50 ; (*b*) tarsus IV, × 83 (*c*) spiracle, × 83.

The spiracle is piriform with the narrow end strongly truncated. Coxa I has two well-separated unequal spurs and the other coxae have each a single spur in the middle of their length. Tarsus IV tapers gradually and is without ventral spurs. The pad attains one-third the length of the claws.

The capitulum is missing in the type-specimen, but in a specimen which undoubtedly belongs to this species it is 0·5 mm. in length. The base is three times as broad as long. The palp is four times as long as broad. Article I has a single long hair on the ventral plate which is totally fused with the article. Article II tapers gradually from the middle towards the posterior end. It bears three hairs on the supra-internal and two on the infra-internal margin. The hypostome has 2 2 rows of teeth with twelve teeth in each row. The distal six teeth in each row are strong and pointed but the proximal six are small and scale-like.

The type-specimen of the nymph is a mutilated example (Reg. No. $\frac{2451}{17}$) from Ceylon : this I have mounted in Canada balsam after sketching the scutum and the slide is preserved in the Indian Museum.

Distribution and hosts.—The species has, so far, been recorded by Robinson from Orissa, Guindy and Saidapet in the Madras Presidency and Ceylon. These records along with the following new ones show that the species is confined to Ceylon, Orissa and Southern India.

Orissa.—Agricultural Farm, Angul (♂s ♀s, off buffalo), Angul City (♂s ♀s, off cattle) and Gonda village (O, off bullock), both in the Angul Dist. Satpara [O, off *Felis viverrina* Bennett and Os, off *Viverricula malaccensis* (Gmel.)] and Barkul (♂s ♀ under stones and on bushes), both in the Puri Dist.

Bombay Presidency.—Mormugoa Bay (♂, host unknown). Kumta in the N. Kanara Dist. (♂s ♀s Os, off bullock and Os, off wild fowl).

Ceylon.—(♂ ♀ O, off pig.).

Amblyomma supinoi Neumann.

1926. *Amblyomma supinoi*, Robinson, *Ticks* II (part 4), pp. 183-186, text-figs. 87, 88.

Male.—The venter is pale yellow and hairy. The spiracle is half as broad as long. The legs are brown with a narrow white ring at the distal end of each segment. The pad attains about one-third the length of the claws.

The following are the measurements of three males :—

		Length	Breadth
Reg. No. $\frac{2431}{17}$ ..	Baradighi, Jalpaiguri Dist. ..	3·75 mm. 4·0 mm.	3·2 mm. 3·3 mm.
Reg. No. $\frac{2424}{17}$ ..	Baradighi, Jalpaiguri Dist. ..	4·0 mm.	3·7 mm.

The length of the capitulum is 0·9—1·4 mm. The palp is five times as long as broad. Article I has one simple hair on its infra-internal margin. Article II is three times as long as broad, with three simple hairs on the infra-internal and about the same number on the supra-internal margin. Article III is longer than broad. The hypostome has 3|3 rows of teeth with about six strong teeth in each row and these are followed posteriorly by about 7.7 rows of scale-like teeth. The external cheliceral article has two cusps. The dorsal process is spear-shaped with a pointed end attached to the internal article.

Female.—The cervical grooves contain larger punctations and extend to the junction of the anterior and middle thirds of the scutum.

The following are the measurements of the scutum of three females :—

		Length	Breadth
Reg. No. $\frac{2431}{17}$ ..	Baradighi, Jalpaiguri Dist. ..	2·5 mm.	2·9 mm.
Reg. No. $\frac{2424}{17}$ ..	Baradighi, Jalpaiguri Dist. ..	2·5 mm. 3·0 mm.	3·2 mm. 3·2 mm.

The capitulum is 1·6—1·8 mm. in length. The external cheliceral article bears three cusps and the dorsal process is crescent-shaped with strongly developed horns.

Distribution and hosts.—The species has so far been recorded by Robinson from Burma and from Baradighi in the Jalpaiguri District, Bengal ; the specimens (two lots of ♂s ♀s, off *Testudo elongata* Blyth) from the last place are in the Indian Museum.

Amblyomma helvolum Koch.

1926. *Amblyomma helvolum*, Robinson, *Ticks* II (part 4), pp. 216-219, text-fig. 106.

Male.—There are only two males in the Indian Museum collection and they are respectively 4·1×3·7 mm. and 3·9×3·3 mm. in size. Robinson has observed six pale markings on the scutum in this species, but in the specimens that I have examined one has the well-developed

scapular markings and traces of the lateral markings, while the other has the right posterior spot and traces of scapular spots. The pad is short and hardly attains one-third the length of the claws.

The base of the capitulum is less than twice as broad as long. The palps are more than five times as long as broad. Article II is three times as long as broad, slightly narrowing towards the proximal end, usually bearing four simple hairs on its infra-internal and an equal number on the supra-internal margin. Article III is longer than broad and the depression for article IV occupies one-third of its ventral surface. The hypostome has 3 3 rows of strong teeth, each containing about seven teeth. Posteriorly these are followed by 5|5 unequal rows of scale-like teeth.

Female.—The smallest female in the collection is 3·5×2·85 mm. in size. The spiracle is sub-triangular with the postero-dorsal angle broad and blunt. The pad hardly attains one-third the length of the claws.

The following are the measurements of the scutum of four females in the collection :—

		Length	Breadth
Reg. No. $\frac{1374}{17}$	.. Zoological Gardens, Calcutta	.. 1·7 mm.	2·0 mm.
Reg. No. $\frac{2387}{17}$	.. Singora, Siam ..	1·7 mm.	1·9 mm.
		1·8 mm.	2·0 mm.
Reg. No. $\frac{2388}{17}$	.. Singora, Siam ..	.. 1·7 mm.	1·9 mm.

The capitulum is compartively less strong than that in the male. Its length is 1·12 mm. The porose areas are large and sub-circular and the interval between them is equal to half their diameter. The external cheliceral article has three cusps.

Distribution and hosts.—The species has so far been recorded off reptiles from Australia, Dutch East Indies, Philippines, Borneo, Java, Sumatra, Pulu Bibi (Warburton, 1926 p. 279), Malayan Peninsula, Nicobar Islands and the Zoological Gardens, Calcutta. I have seen the following specimens :—

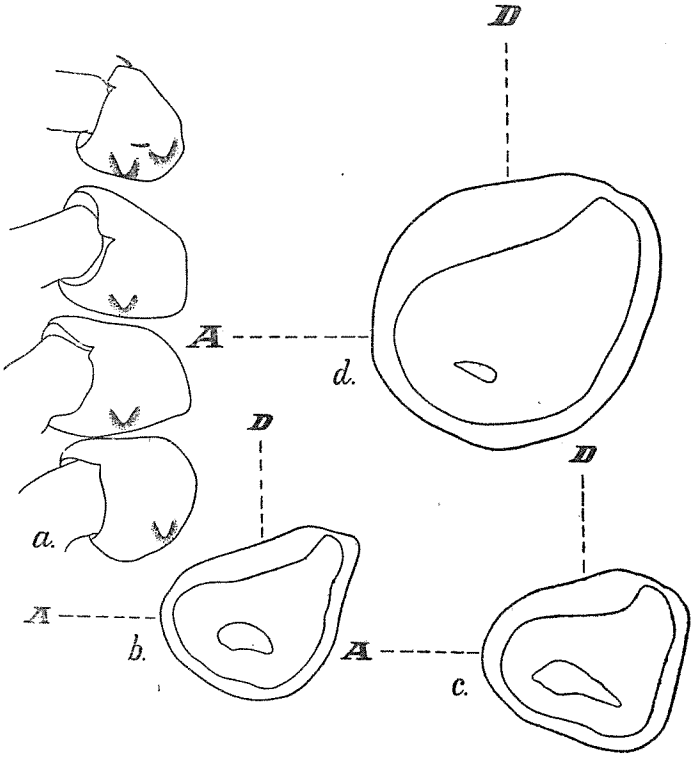
Siam.—Singora [2♀s, off *Coluber radiatus* Schleg. and 2♀s, off *Varanus nebulosus* (Gray)].

Amblyomma nitidum S. Hirst and L. F. Hirst.

1926. *Amblyomma nitidum*, Robinson, *Ticks* II (part 4), pp. 240-241.

Male.—The size varies from 3·5×3·0 mm. to 4·75×4·0 mm. The cervical grooves are represented by short, oval, deep and converging depressions which are continued posteriorly by broad superficial diverging areas. The punctations are of medium size, sub-equal and numerous. A slightly elevated pseudo-scutum is visible in all the specimens that I have examined. The postero-median and accessory stripes are present and three lateral spots are also visible. The spiracle is sub-triangular in shape with the postero-dorsal angle elongated and truncated. In the specimens before me the spur on coxa IV is not longer than the spurs on coxae II and III as is stated to be the case in Robinson's description.

Tarsus IV tapers gradually to a ventral spur which is preceded by another similar but smaller one. The pad attains less than half the length of the claws.



TEXT-FIG. 43.—*Amblyomma nitidum*: (*a*) ♂, coxal armature, × 35; (*b*) ♂, spiracle, × 34; (*c*) ♀, spiracle, × 34; (*d*) nymph, spiracle, × 210.

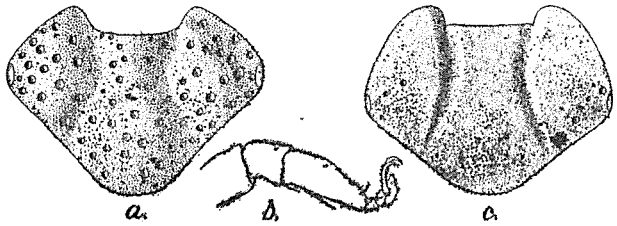
The capitulum is 0·99 mm. in length. The base is sub-rectangular with the lateral sides slightly convex. The palp is four times as long as broad. Article II narrows gradually from the middle towards the proximal end and is one and a half times as long as the third article, which is slightly longer than broad. This article bears four simple short hairs on the infra-internal and usually three hairs on the supra-internal margin. The hypostome has 4|4 rows of teeth with about five strong teeth in each row and these are then followed by many scale-like teeth to the proximal end. The size and number of the teeth increase from the inner to the outer rows.

Female.—The size of the scutum is 1·8×2·3 mm. and the punctations are deep and sub-equal. The postero-dorsal prolongation of the spiracle is broader and more truncated than in the male.

The capitulum is 1·2 mm. in length. The porose areas are large and sub-circular, and the interval between them is equal to their diameter. The palps are more than five times as long as broad. The cheliceral article has three cusps, the proximal being well separated from the middle. The dorsal process is crescent-shaped.

Nymph.—The scutum is like that of the female but is comparatively broader. Its size varies from 0·55×0·8 mm. to 0·62×0·92 mm. The eyes are flat and are somewhat indistinct. The cervical grooves are well indicated. They are at first convergent; they then diverge and reach the posterior margin. The punctations are fairly numerous and equal. The spiracle is pear-shaped. The coxal armature is as in the female. The tarsi are without ventral spurs.

The capitulum is 0·45 mm. in length and closely resembles that of the female. The palps are four times as long as broad; all the articles are quite distinct and there is no trace of fusion. Article IV is comparatively longer than that of the adult. The hypostome has 3|3 rows of teeth with usually five strong teeth in each row and these are followed posteriorly by 2|2 rows of squamiform teeth.



TEXT-FIG. 44.—*Amblyomma nitidum*: (a) nymph, scutum, × 39; (*b*) nymph, tarsus IV, × 62; (*c*) larva, scutum, × 79.

Larva.—The scutum is comparatively broader than that in the nymph and the posterior angle is more obtuse than in any other stage. Its size is 0·3×0·55 mm. The cervical grooves are at first parallel, then slightly divergent and finally reach the posterior margin. Coxa I bears two well-separated short spurs, the external being longer than the internal; the other coxae have each a short triangular spur about the middle of their length.

The capitulum is 0·25 mm. in length and considerably resembles that of the nymph. The base is sub-triangular. The palps are four times as long as broad. All the articles of the palp are distinct and show no trace of fusion. Article II bears a simple hair on the infra-internal margin. The hypostome has 2|2 rows of teeth with four strong teeth in each row and these are then followed posteriorly by 2 2 rows of scale-like teeth.

Distribution and hosts.—Only the type-specimens, a ♂ and a ♀, are recorded off a sea-snake from the Solomon Islands in the South Pacific Ocean: these are in the British Museum. ♂s ♀s Os *Ls*, off *Laticauda laticaudatus* (Linn.) from Port Blair, Andamans, are in the Indian Museum. Sea-snakes of the genus *Platurus* (=*Laticauda*) are known[1] to go on long excursions on land and they thus get infested with ticks.

Amblyomma sublaeve Neumann.

1926. *Amblyomma sublaeve*, Robinson, *Ticks* II (part 4), pp. 244-247, text-figs. 120, 121.

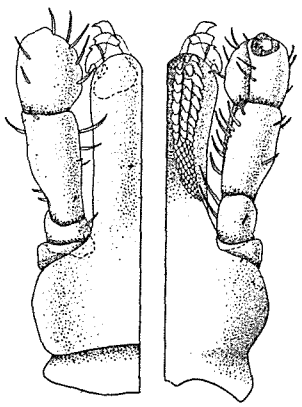
Male.—Robinson, in his account of this species, has mentioned the presence of scattered hairs on the marginal parts but in all the specimens

[1] Boulenger, *Faun. Brit. Ind., Rept. Batrach.* p. 395 (1890).

that I have examined hairs are absent. The anterior major portion of the scutum is either unpunctate or only indistinctly punctate . This I believe is due to the fact that this portion of scutum is, in the condition of attachment, covered by the scales of the host, which generally is some species of the genus *Manis* Linn. The pad is excessively small and hardly attains one-fourth the length of the claws.

The following are the measurements of the males from different localities—

		Length	Breadth
Reg. No. $\frac{66}{18}$	.. Nagpur	.. 4·0 mm.	3·5 mm.
Reg. No. $\frac{67}{18}$	.. Nagpur	.. 3·25 mm. 4·0 mm.	2·5 mm. 3·5 mm.
Reg. No. $\frac{961}{17}$	.. Karachi	.. 4·75 mm.	3·75 mm.
Reg. No. $\frac{959}{17}$	.. Zoological Gardens, Calcutta	.. 5·5 mm.	4·5 mm.
Reg. No. $\frac{2044}{17}$	.. Baradighi, Jalpaiguri Dist.	.. 3·0 mm.	2·5 mm.



TEXT-FIG. 45.—*Amblyomma sublaeve* ♂: (*a*) capitulum, dorsal aspect, × 34; (*b*) capitulum, ventral aspect, × 34.

The length of the capitulum varies from 0·96 mm. to 1·28 mm. The base is rectangular with the lateral sides slightly convex; it is less than twice as broad as long. The dorsal ridge is straight, while the ventral ridge is indistinct. The palps are four times as long as broad. The proximal half of article II tapers gradually towards the posterior end, thus making a slight lateral prominence in the middle of its external side. It is about twice as long as broad and usually bears six simple hairs on the infra-internal margin. Article III is slightly longer than broad. The hypostome has 3|3 rows of teeth with about eight strong teeth in each row. These are followed posteriorly by 4|4 unequal rows of scale-like teeth. The external cheliceral article has two cusps, the distal being excessively small.

Female.—The cervical grooves in the specimens that I have examined are deep and convergent anteriorly but they diverge posteriorly and in a few cases attain the posterior margin of the scutum. The marginal grooves are distinctly visible in the smaller specimens but they are indistinct in the larger specimens. They are not continuous and each of them includes the first three festoons of the side.

The following are the measurements of the scutum of three females from different places :—

		Length	Breadth
Reg. No. $\frac{67}{18}$ .. Nagpur	..	2·2 mm. 1·9 mm.	2·6 mm. 2·3 mm.
Reg. No. $\frac{1100}{17}$ .. Kakhyen Hills, Burma	..	2·3 mm.	2·7 mm.

The capitulum is 1·26—1·4 mm. in length. The base is twice as broad as long. The external cheliceral article has three cusps and the dorsal process is crescent-shaped with well developed horns.

Distribution and hosts.—The species has, so far, been recorded by Robinson from Dutch East Indies, Java, Sumatra, Federated Malay States, Siam, China, Burma and India. In the last country it has been recorded from Chittagong, Chota-Nagpur, Nagpur, Ghodasgaon in E. Khandesh Dist. and Karachi. I have seen specimens from the following localities :—

Bengal.—Calcutta Zoological Gardens (♂, off *Manis pentadactyla* Linn.). Baradighi Tea Estate in the Jalpaiguri Dist. [♂, off *Nicoria tricarinata* (Blyth)].

Central Provinces.—Nagpur (3 lots of ♂s ♀s, off *Manis* sp.).

Punjab.—Rajanpur in the Dera Ghazi Khan Dist. (♀s, off *Vesperugo abramus* Temminck).

Bombay Presidency.—Ahmedabad (♂, host unknown).

Amblyomma testudinarium Koch.

1926. *Amblyomma testudinarium*, Robinson, *Ticks* II (part 4), pp. 253-257, text-figs. 125, 126.

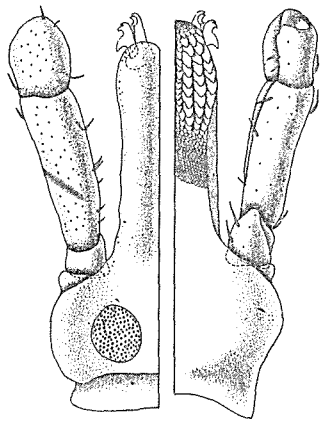
Male.—The spiracle is sub-triangular with the postero-dorsal extension broad and truncated. The pad attains one-third the length of the claws. Haller's organ is conspicuously small. The following are the measurements of males from different places.

		Length	Breadth
Reg. No. $\frac{1201}{17}$ .. Kobo in the Abor country	..	5·5 mm. 4·5 mm.	5·0 mm. 4·0 mm.
Reg. No. $\frac{1203}{17}$ .. Kobo in the Abor country	..	4·5 mm.	4·0 mm.
Reg. No. $\frac{69}{18}$ .. Dipur in the Kamrup Dist.	..	6·0 mm.	5·5 mm.

The length of the capitulum varies from 1·85 mm. to 2·25 mm. The case is rectangular with the lateral sides convex externally ; the cornua are obsolete. It is about twice as broad as long and is without any definite ventral ridge. The palp is four times as long as broad. The dorsal surface of article I is only half as long as the ventral. The ventral plate is sub-triangular and is fused with article I. It bears two short

simple hairs. Article II is about three times as long as broad and usually bears five simple hairs on the infra-internal and an equal number on the supra-internal margin. Article III is one and a half times as long as broad. The anterior one-fourth of its ventral surface is occupied by the depression for the fourth article which is very small. The hypostome has 4/4 rows of teeth; in each row there are usually eight strong teeth. These rows extend back for about the distal one-third and are then followed posteriorly by numerous (about 10/10) rows of squamiform teeth. The external cheliceral article has a single lateral cusp and an anterior conical point. The dorsal process is crescent-shaped.

Female.—The unfed female is 4·5×4·0 mm. in size. The size of the scutum varies from 2·4×2·9 mm. to 3·5×4·25 mm.

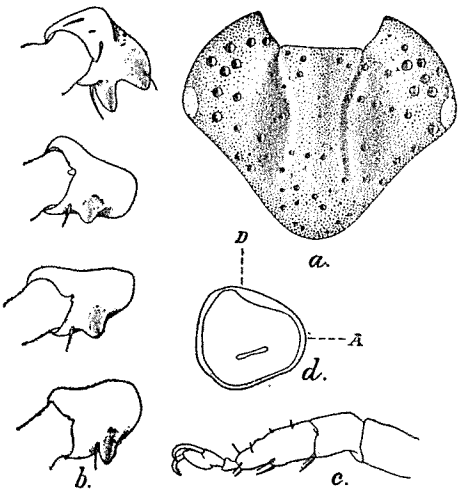


TEXT-FIG. 46.—*Amblyomma testudinarium* ♀: (*a*) capitulum, dorsal aspect, × 23; (*b*) capitulum, ventral aspect, × 23.

The capitulum is comparatively stronger than that of the male. Its length varies from 2·0 mm. to 2·5 mm. The base is broader than that of the male. The porose areas are large and sub-circular, the interval between them being less than their diameter. The palp is five times as long as broad. The external cheliceral article has three cusps, and the dorsal process is crescent-shaped.

Nymph.—The scutum is sub-cordiform, being broadest in the anterior half. It is 0·8×1·1 mm. in size and is of a brown colour. The antero-lateral sides are convex and are much shorter than the postero-lateral, which are slightly concave and meet each other in a rounded angle. The punctations are sub-equal and are sparsely scattered; those on the lateral fields being larger than those on the median field. The cervical grooves are deep and convergent anteriorly but are shallow and broad posteriorly. They do not reach the posterior margin. The spiracle is sub-triangular with the angles more rounded than in the female. Coxa I has two well-separated spurs, the external of which is longer than the internal. The other coxae have each a short sub-triangular spur in the middle. Tarsus IV tapers gradually and is without any ventral spur. The pad attains about half the length of the claws.

The capitulum greatly resembles that of the adult and is 0·53 mm. in length. The base is rectangular with the lateral sides convex. The cornua are absent. The palps are as in the female, except that the third article is comparatively longer. Article I has one simple hair on the infra-internal margin. Article II has two short hairs on the supra-internal and two long hairs on the infra-internal margin. The hypostome is armed with 2|2 rows of teeth, with about six strong teeth in each row, and these are then followed by about eight scale-like teeth.



TEXT-FIG. 47.—*Amblyomma testudinarium* nymph: (*a*) scutum, × 40; (*b*) Coxal armature, × 62; (*c*) tarsus IV, × 62; (*d*) spiracle, ×62.

The type-specimens (Reg. no. $\frac{55}{8}$) of the nymph are in the India Museum; they were taken along with the adults off a tiger shot near Naihati in the Twenty-four Parganas Dist.

Distribution and hosts.—The species has, so far, been recorded from Japan, Formosa, Borneo, Java, Sumatra, Federated Malay States, Cochin China, Annam, Burma, Ceylon and in India from Assam, Darjeeling Dist. and Bombay. It attacks both wild and domestic animals.

Burma.—Arakan Yomas, Chauung, Upper Myinudaung Reserve, Henzada Dist., Lower Burma (O, host unknown).

Assam.—Dejoo in the Lakhimpur Dist. (♀, host unknown). Dipur in the Kamrup Dist. (♂s ♀, off bullock). Sibsagar (♀, off *Felis tigris*) and Nagabera (♂, off tiger), both in the Goalpara Dist. Craig Park Tea Estate (♀, off Nelore cow, Muktesar Coll.) and Kalain (♂s ♀s, off tiger, Muktesar Coll.), both in the Cachar Dist. Sikkim, (♂ host unknown).

Bengal.—Pashok, alt. 1,000 ft. in the Darjeeling Dist. (♂, host unknown). Naihati [1] (♂s ♀s Os, off tiger, C. S. T. M. Coll.). Rangamati in the Chittagong Dist. (♂s, off Sambhar deer).

Bombay.—Castle Rock in the N. Kanara Dist. (♀, off bullock).

[1] Through the courtesy of Prof. C. Strickland the nymphs have been retained for the Indian Museum.

Coorg State.—(O, off bullock).
Ceylon.—Peradeniya, in the jungle (♀, host unknown).

Genus **Aponomma** Neumann.

1831. *Ixodes (en partim)*, Müller, *Nova Acta Physico-medica* XV (part 2), pp. 235, 236.
1844. *Amblyomma (en partim)*, Koch, *Arch. Naturgesch.* X (Bd. 1), p. 223.
1845. *Ixodes (en partim)*, Lucas, *Ann. Soc. Ent. France* (2) III, pp. 61-65.
1877. *Ophiodes*, Murray, *Economic Entomology, Aptera*, p. 203 (London).
1899. *Aponomma*, Neumann, *Mém. Soc. Zool. France* XII, pp. 180, 181.
1905. *Neumanniella*, Lahille, *Repúbl. Argent. An. Minist. Agr. Sec. Zootec. Bact. Vet. Zool.* II, p. 16.
1908. *Aponomma* and *Neumaniella*, Howard, *Ann. Transvaal Mus.* I, pp. 147, 153, 154.
1911. *Amblyomma (Aponomma)*, Nuttall and Warburton, *Ticks* part 2, pp. 109, 111, 126.
1911. *Aponomma*, Neumann, *Das Tierreich* XXVI, p. 92.
1913. *Aponomma*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 622 (Madras).
1916. *Amblyomma (Aponomma)*, Nuttall, *Bull. Entom. Research* VI, p. 339.
1926. *Amblyomma (Aponomma)*, Fielding, *Commonwealth Austral. Dept. Health Serv. Publ.* (Trop. Divis.) No. 9, p. 86.

This genus was established in 1899 by Neumann owing to Murray's generic name *Ophiodes* being pre-occupied by a genus of the family Anguidae, and Nuttall and Warburton in 1911 considered it to be a subgenus of *Amblyomma*. In my opinion such important characters as the absence of eyes and the comparatively broad body are sufficient to warrant one regarding it as a genus distinct from *Amblyomma*. The first character alone is enough to distinguish it as a separate genus in the family Ixodidae. There are species of the genus *Amblyomma* in which the eyes are indistinct but there are none in which they are totally absent, and I agree with Neumann in regarding *Aponomma* as a distinct genus.

The genus is represented in India by four species, of which two, *A. gervaisi* (Lucas) with its var. *lucasi* Warburton and *A. laeve* Neumann, are represented in the Indian Museum collection. Two other species, *A. pattoni* Neumann and *A. trimaculatum* (Lucas) have been recorded by Warburton [1] from Ceylon; the former of these was originally described by Neumann [2] from India, having been obtained at Saidapet in the Vellore District. I have not seen specimens of these two species.

Key to the Indian species of the genus *Aponomma*.

MALES.

I. Scutum either ornate or inornate with numerous punctations.
  A. Scutum inornate; punctations markedly unequal .. .. *pattoni.*
  B. Scutum ornate, with metallic green background divided into five or seven blotches by brown stripes and spots; punctations almost subequal.

[1] Warburton, *Spolia Zeylanica* XIII, p. 256 (1925). Apparently *A. primaculatum* (Lucas) mentioned in this work is a misprint for *A. trimaculatum* (Lucas).
[2] Neumann, *Ann. Sci. Nat.* (9) XII, pp. 163-165, text-figs. 2, 3 (1910).

I. Coxa I with two markedly unequal spurs, the internal being absent or obsolete; punctations comparatively large; brown stripes and spots occupying comparatively a small portion of the surface of the scutum: comparatively small in size .. .. .. *gervaisi* forma *typica*.

II. Coxa I with two distinct sub-equal spurs; punctations comparatively small; brown stripes and spots occupying comparatively a large portion of the surface of the scutum; comparatively large in size .. *gervaisi* var. *lucasi*.

II. Scutum inornate with few, superficial fine punctations, very few in the median area .. .. *laeve*.

FEMALES.

I. Scutum ornate, with metallic green background divided by brown stripes into three blotches; punctations large and numerous.

A. Scutum broader than long; numerous punctutions; tarsi spurred; hypostome 3|3.

I. Scutum with posterior angle rounded; punctations comparatively large; coxa I with two strongly unequal spurs, the internal being obsolete .. .. *gervaisi* forma *typica*.

II. Scutum with posterior angle truncated; punctations comparatively small; coxa I with two sub-equal distinct spurs .. *gervaisi* var. *lucasi*.

B. Scutum as long as or longer than broad; punctations large and few; tarsi not spurred; hypostome 4|4 .. .. .. *trimaculatum*.

II. Scutum inornate, uniformly brown; punctations few, sparsely scattered and fine .. .. *laeve*.

NYMPHS.

I. Coxa I with one distinct spur; punctations comparatively few.

A. Tarsus IV with hump .. .. *gervaisi* forma *typica*.

B. Tarsus IV without hump .. .. *laeve*.

II. Coxa I with two distinct spurs; punctations more numerous .. .. .. *gervaisi* var. *lucasi*.

Aponomma gervaisi (Lucas).

1899.[1] *Aponomma gervaisi* (*en partim*), Neumann, *Mém. Soc. Zool. France* XII, pp. 182-185, text-figs. 35-39.
1901. *Aponomma gervaisi*, *id.*, *ibid.*, XIV, p. 291.
1910.[2] *Aponomma gervaisi*, Warburton, *Parasitology* III, pp. 405, 406, text-fig. 9.
1911.[1] *Aponomma gervaisi*, Neumann, *Das Tierreich* XXVI, pp. 93, 94, text-figs. 38-41.

Male.—The body is nearly as broad as or slightly broader than long. The ornamentation of the scutum exhibits variation. The brown stripes and spots on the metallic green ground generally occupy a much lesser area. The falciform stripe is fused with the antero-accessory stripes which diverge anteriorly and reach the external margins and thus divide the lateral metallic green blotches into two. The frontal spots are fused with the antero-accessory stripes. The postero-median stripe is narrow

[1] Earlier references will be found in these works.
[2] I agree with Warburton that Neumann's description is applicable to both the *forma typica* and var. *lucasi*.

posteriorly, but broad and fused with the falciform stripe anteriorly. The postero-accessory stripes are short and bend inwards and usually meet the falciform stripe. The cervical spots are well developed. The cervical stripes are divergent posteriorly and generally meet the antero-accessory stripes. There is a brown area between the anterior portions of the cervical stripes. A marginal brown band on each side starts from the cervical spot and ends in front of the extreme festoon. The three lateral spots generally fuse with the antero-accessory stripe of the side. The festoons are generally of a metallic green colour but in a few cases they are brown. The punctations are large and sub-equal. The cervical grooves are deep and convex externally. The lateral grooves are absent. The emargination is deep. The genital aperture lies opposite coxa II and is strengthened by a post-genital chitinous plate. The anus is oval and is broader than long. The spiracle is comma-shaped with the antero-dorsal portion of the margin considerably thickened and the porous portion has a strong antero-dorsal curve. Coxa I has one short blunt spur near the internal angle and in a few cases a second small obsolete spur is present internal to it. According to Warburton coxa I is faintly bidentate but I hesitate to call it so as the internal spur, even when it is present, is hardly prominent. The other coxae have each a similar spur on the internal angle. The pad is very short and hardly attains to one-fourth the length of the claws.

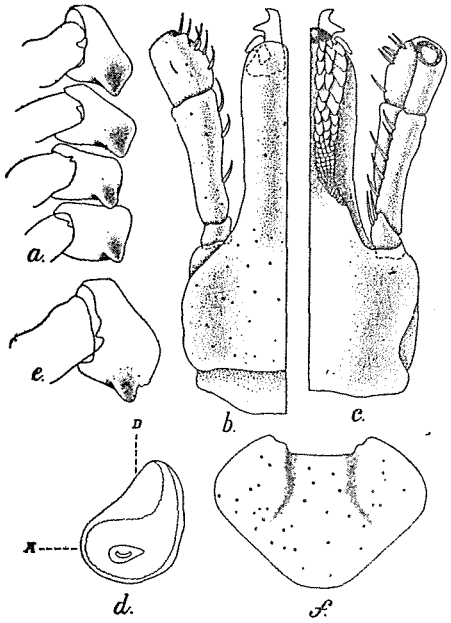
The following are the measurements of males from different localities :—

		Length	Breadth
Reg. No. $\frac{909}{17}$ .. Karachi		1·9 mm. 2·3 mm.	2·0 mm. 2·4 mm.
Reg. No. $\frac{906}{17}$ .. Agra		2·2 mm. 1·9 mm.	2·2 mm. 2·0 mm.
Reg. No. $\frac{908}{17}$ .. Sibsagar		2·3 mm.	2·3 mm.
Reg. No. $\frac{927}{17}$ .. Agra		2·4 mm. 2·0 mm.	2·5 mm. 2·1 mm.

The capitulum is 0·83 mm. in length and is less than twice as long as broad. The base is sub-rectangular with the lateral sides slightly convex, and is twice as broad as long. The cornua are obsolete. The ventral ridge is absent. The palps are four times as long as broad. The second article is one and a half times as long as the third. Article I is visible both dorsally and ventrally and is provided with a ventral plate bearing two long simple hairs. Article II is about three times as long as broad and gradually increases in breadth from the proximal end to the distal. There are about three simple hairs on the supra-internal margin and five to six on the infra-internal margin. Article III is sub-rectangular and is one and a half times as long as broad. The hypostome has 3|3 rows of teeth, with about seven strong teeth in each row and these are then followed by 4|4 rows of small scale-like teeth.

Female.—The smallest female in the collection, which is almost an unfed example, is 2·8×2·5 mm. The scutum is cordiform with a sinuous outline. It is broader than long and is broadest in the anterior one-third.

The brown stripes occupy a considerable portion of the scutum and as a result of this the metallic green background is reduced to three widely separated blotches. The emargination is moderately deep. The cervical grooves are short and deep with an external convexity, and they



TEXT-FIG. 48.—*Aponomma gervaisi*: (*a*) ♂, coxal armature, × 34; (*b*) ♂, capitulum, dorsal aspect, × 55; (*c*) ♂, capitulum, ventral aspect, × 55; (*d*) ♀, spiracle, × 35; (*e*) ♀, coxa I, × 34; (*f*) nymph, scutum, × 34.

are continued posteriorly by shallow and slightly divergent depressions. The punctations are large and unequal. The festoons are distinct in the younger specimens and are broader than long. The marginal grooves are absent. The spiracle is sub-triangular with a short posteriorly pointed macula. Its antero-dorsal margin is much thickened. The coxal armature is as in the male except that the first coxa has a better indication of the internal spur. There is only one comparatively small tarsal spur.

The following are the measurements of the scutum of females from different places :—

		Length	Breadth
Reg. No. $\frac{2164}{17}$ ..	Niroddumunia, Trincomali Dist., Ceylon	1·6 mm. 1·4 mm.	1·9 mm. 1·6 mm.
Reg. No. $\frac{909}{17}$ ..	Karachi	1·7 mm. 1·6 mm. 1·4 mm.	1·8 mm. 1·9 mm. 1·7 mm.

The capitulum is 0·83 mm. in length and differs from that of the male in the dorsal ridge being concave posteriorly. The lateral sides of the base are more convex externally and the cornua are a little more prominent than in the male. The base is more nearly sub-triangular than sub-rectangular. The dorsal process is very small and is crescent-shaped.

Nymph.—The scutum is cordiform, being broadest in the anterior half. Its size is 0·6 × 0·83 mm. and its colour light brown, being inornate. The postero-lateral sides are either slightly concave or straight. The posterior angle is broadly rounded. The cervical grooves are narrow, deep, parallel and divergent posteriorly; they hardly reach the posterior margin. The punctations are deep; they are few in number and are sparsely scattered. The spiracle is comma-shaped with the free end of the tail obliquely truncated. It is twice as long as broad. The macula is very small and is sub-circular. Coxa I has a short blunt spur near the internal angle with, in a few cases, an obsolete spur internal to it. The other coxae have each a short blunt spur near the middle of their length. Tarsus IV possesses a hump about the middle of the distal portion. The claws are comparatively longer than those in the adult.

The capitulum is 0·33 mm. in length. The base is sub-rectangular with poorly developed cornua. It is more than three times as broad as long. The palps are as in the female. Article I has one simple hair on the infra-internal margin. Article II possesses two or three hairs on the infra-internal margin. The hypostome has 2|2 rows of teeth with five strong teeth in each row and these are then followed by 3|3 rows of scale-like teeth. In other respects it is like that of the female.

Distribution and hosts.—Neumann has recorded this species in Asia from Java, Burma, Bengal, the Coromandel Coast and Ceylon and in Africa from Loango, Togo and Senegal. Warburton has recorded it from the Zoological Gardens, Calcutta, Agra, Karachi and Ceylon and he adds *Varanus bengalensis* (Daudin), *Calotes versicolor* (Daudin), *Zamenis mucosus* (Linn.) and *Naia tripudians* (Merr.) to the list of its hosts. The following disconnected records show that the species is found throughout the whole of India and Ceylon :—

Siam.—Singora [♂♀, off *Varanus nebulosus* (Gray)].

Assam.—Sibsagar (♂s ♀ O, off *Varanus bengalensis*).

Bengal.—Zoological Gardens, Calcutta (Os, off *Naia tripudians* and ♀s, off *Varanus bengalensis*).

Nepal.—(♂, off *Zamenis mucosus*).

United Provinces.—Agra Museum [3 lots of ♂s ♀s Os, off *Varanus bengalensis* and ♂s ♀s, off *Varanus nebulosus* (Gray)]. Hathras in the Aligarh Dist. (♂s ♀s Os, off *Varanus* sp.).

Central Provinces.—Nagpur (♀, off *Varanus bengalensis*).

Madras Presidency.—Barkuda Island, Chilka Lake in the Ganjjam Dist. (♂s ♀s, off *Varanus bengalensis*).

Bombay Presidency.—Karachi Museum (♂s ♀s Os, off *Varanus bengalensis*).

Ceylon.—Niroddumunia in the Trincomali Dist. (♂s, off *Varanus bengalensis*).

Var. **lucasi** Warburton.

1899. *Aponomma gervaisi* (*en partim*), Neumann, *Mem. Soc. Zool. France* XII, pp. 182—185.

1910. *Aponomma gervaisi* var. *lucasi*, Warburton, *Parasitolog* III, pp. 406, 407, text-fig. 10.

Male.—The male shows a considerable degree of variation in size and is comparatively larger than that of the *forma typica*. The orna-

mentation of the scutum shows an extensive increase in the brown areas. This is brought about by the enlargement of the various stripes and spots. In certain cases the green spots are reduced to such an extent that either they are totally absent or are represented only by two spots in the posterior region. The punctations are small and unequal, larger ones being more numerous along the periphery. In a very few cases the punctations are absent in the central area of the scutum. The venter is yellowish-white, punctate and hairy. Coxa I has two blunt sub-equal spurs.

The following are the measurements of males from different localities :—

		Length	Breadth
Reg. No. $\frac{2430}{17}$ .. Calcutta		2·6 mm.	2·65 mm.
		2·35 mm.	2·3 mm.
		2·4 mm.	2·5 mm.
Reg. No. $\frac{2436}{17}$ .. Calcutta		2·7 mm.	2·7 mm.
		2·5 mm.	2·6 mm.
Reg. No. $\frac{932}{17}$ .. Locality unknown		2·5 mm.	2·7 mm.
Reg. No. $\frac{939}{17}$ .. Calcutta		2·9 mm.	2·95 mm.
Reg. No. $\frac{936}{17}$ .. Calcutta		3·0 mm.	3·0 mm.
Reg. No. $\frac{1125}{17}$ .. Almora		2·1 mm.	2·1 mm.

The capitulum is 0·75 mm. in length. The palps are comparatively longer and more hairy than those in the *forma typica*.

Female.—The scutum is as in the typical form but the broadest portion is more posterior in position. The cervical grooves are short, convex externally and open into slightly divergent and shallow depressions. The punctations are small and comparatively fewer in number than in the *forma typica*. The coxal armature is as in the male.

The following are the measurements of the scutum of females from Calcutta :—

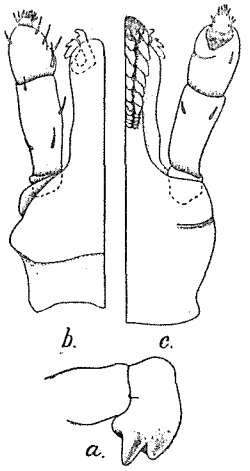
	Length	Breadth
Reg. No. $\frac{2423}{17}$ .. Calcutta	1·3 mm.	1·9 mm.
Reg. No. $\frac{936}{17}$ .. Calcutta	1·6 mm.	2·0 mm.

The capitulum is 0·8—1·16 mm. in length. The palps are five times as long as broad.

Nymph.—The unfed nymph is sub-quadrangular in outline and is as broad as long. The size is 1·1 × 1·1 mm. The posterior angle of the scutum is slightly truncate. The punctations are more numerous than those of the nymph of the typical form. The festoons are distinct in the younger specimens and are longer than broad, The spiracle tends to be more oval than in the typical form.

The capitulum is 0·38 mm. in length with obsolete cornua.

Larva.—The scutum is of a light brown colour with a reticulate surface. Its shape is cordiform and its size is 0·35×0·45 mm. The cervical grooves are represented by sub-parallel elongate and deep depressions and they do not extend beyond half the length of the scutum. The



TEXT-FIG. 49.—*Aponomma gervaisi* var. *lucasi*: (*a*) ♀, coxa I, × 34; (*b*) larva, capitulum, dorsal aspect, × 141; (*c*) larva, capitulum, ventral aspect, × 141.

legs and capitulum are light brown in colour. Each coxa has one short spur near the internal angle.

The capitulum is 0·22 mm. in length. The base is sub-triangular, without cornua. The palps have all the articles distinct. Article I is visible both dorsally and ventrally. Article IV is terminal in position and is visible dorsally. The hypostome has 2|2 rows of teeth which gradually decrease in size towards the posterior end.

Nuttall and Warburton identified two lots from the Indian Museum collection (Reg. Nos. $\frac{2349}{17}$ and $\frac{1127}{17}$) as *A. laeve* var. *paradoxa*. I have failed to find any description of this variety and it is probably only a manuscript name; in my opinion these specimens are nothing more than inornate examples of *A. gervaisi* var. *lucasi*. The tendency to become less ornate is observable in this variety. Some of the specimens of this variety can easily be passed as inornate if they are not examined very carefully and these are connected by various intermediate grades with the fully ornate members of *A. gervaisi* var. *lucasi*. These feebly ornate specimens if kept for any length of time in alcohol become entirely inornate. I have not included *A. laeve* var. *paradoxa* in the synonymy of *A. gervaisi* var. *lucasi*, because, as far as I know, the former exists only in name and has never been described and recorded anywhere by its author.

Distribution and hosts.—The variety has almost as wide a distribution in India as the *forma typica*. In a few instances the hosts are mammals but in these cases the association is, I think, only a casual one. War-

burton described this variety from various reptiles in the Zoological Gardens, Calcutta.

Siam.—Kohyaw near Tale Sap, Singora [♂s ♀s, off *Varanus nebulosus* (Gray)].

Lower Burma.—Moulmein (♀, off *Varanus nebulosus*). Byikhwaaw Bay, Tavoy (♀, off *Naia tripudians* and ♂s ♀s Os, off *Varanus salvator*).

Narcondam Island in the Andaman Sea (♂s O, off *Varanus salvator*).

Nicobar Islands.—Nancowry (♂s, off *Varanus bengalensis*).

Assam.—(♂s, off *Varanus salvator*).

Bengal Presidency.—Rangpur [♂s ♀, off *Varanus salvator* (Laurenti)]. Raniganj in the Burdwan Dist. [♂ Os, off *Naia tripudians* (Merrem)]. Jessore (♂ ♀, off *Python* sp.). Zoological Gardens, Calcutta [4 lots of ♂s ♀s Os, off *Python molurus* (Linn.), ♂ ♀, off *Python reticulatus* (Schneider), ♂s ♀s Os, off *Python* sp., ♂s ♀s Os, off *Varanus nebulosus* (Gray), ♂s ♀s, off *Varanus salvator*, ♂s ♀s Os, off *Varanus* sp., 3 lots of ♂s ♀s Os, off *Naia tripudians*, 2 lots of ♂ ♀s O, off *Naia bungarus* Schlegel, ♂s ♀s Os, off *Gongylophis conicus* (Schneid.), ♂s ♀s Os, off *Bungarus fasciatus* (Schneid.), ♂s ♀s, off *Vipera russellii* (Shaw), ♂, off *Zamenis mucosus*, ♂s ♀s, off *Bos frontalis* Lambert and ♂s ♀s, off *Ovis nahura* Hodgson].

Bihar and Orissa.—Jogidih in the Hazaribagh Dist. (2 lots of Os, off wolf or jackal). Barkul in the Puri Dist. (Os, off *Lutra macrodus* Gray).

United Provinces.—Kacha in the Naini-Tal Dist. [♂s, off *Varanus bengalensis* (Daudin)]. Almora, alt. 5,400 ft. [♂s ♀, off *Zamenis mucosus* (Linn.)].

Ceylon.—Peradeniya (♂ ♀s Os, off *Varanus salvator*).

Aponomma laeve Neumann.

1899. *Aponomma laeve*, Neumann, *Mém. Soc. Zool. France* XII, pp. 190, 191.
1901. *Aponomma laeva*, Neumann, *Mém. Soc. Zool. France* XIV, p. 291.
1911. *Aponomma laeve laeve*, Neumann, *Das Tierreich* XXVI, p. 95.

Male.—The body is roughly quadrangular with the lateral sides slightly convex. It narrows slightly towards the anterior end, being broadest near the spiracles. The scutum is yellow-ocher to brick-red in colour and its size varies from 2·1 × 2·0 mm. to 2·4 × 2·4 mm. The punctations are superficial, fine, equal and sparsely scattered, and are generally absent in the greater part of the median area of the scutum. The cervical grooves are short deep depressions with a convexity towards the external side. The marginal grooves are absent. The festoons are broader than long with rather indistinct separating grooves. The spiracle is elongate-oval and is twice as long as broad : it narrows gradually toward the dorsal end. The antero-dorsal portion of the margin is less thickened than in *A. gervaisi*. Coxa I has one short pointed spur near the internal angle and in a few cases an obsolete spur-like projection is present internal to it. Coxae II-IV have each a short and more pointed spur than in *A. gervaisi* near the middle of their length, that on

coxa IV being slightly larger than the others. Tarsus IV is slightly humped prior to tapering into a long spur but the hump is not so prominent as in *A. gervaisi*. The pads attain one-third the length of the claws.

The capitulum is 0·66—0·75 mm. in length. It resembles that of *A. gervaisi* except that the palps are slightly longer, being five times as long as broad.

Female.—The scutum is cordiform and its size is 1·5×1·75 mm. The cervical grooves are narrow and sub-parallel and extend up to two-thirds the length of the scutum. The punctations are fine, equal, superficial, and are sparsely scattered. The spiracle is as in *A. gervaisi*. The coxal armature is as in the male but is less strongly developed.

Nymph.—It resembles the nymph of *A. gervaisi* so much that it cannot easily be differentiated from it. It differs only in the absence of the hump on tarsus IV, which tapers gradually.

Distribution and hosts.—The species has, so far, been recorded from Ceylon (Warburton, 1910) in Asia, from the Sudan (King, 1908, p. 202), Tanganyika territory, Congo and South West Africa (Warburton, 1922) in Africa and from Patagonia in the Argentine, S. America. Dr. H. H. Marshall's collection in the Indian Museum coontains five lots of this species, the locality and the host of which are not known. I have also seen specimens from Dhardes near Mahabaleshwar in the Satara Dist. (♂, off rat-snake) in the Bombay Presidency and Coimbatore (♂s, ♀s Os, off cobra Kasauli coll.) in the Madras Presidency.

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EXPLANATION OF PLATE VIII.

Haemaphysalis parva Neumann.

FIG. 1. Female, scutum : × 75.

Haemaphysalis cornigera var. *anomala* Warburton.

FIG. 2. Female, scutum : × 50.

Rhipicephalus haemaphysaloides Supino.

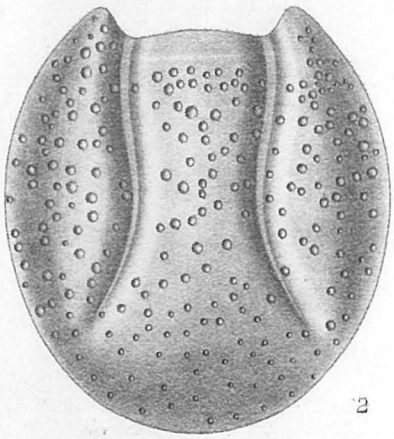
FIG. 3. Male, scutum : × 23.
FIG. 4. Female, scutum : × 35.

Boophilus australis (Fuller).

FIG. 5. Female, scutum : × 72.

Dermacentor auratus Supino.

FIG. 6. Female, scutum : × 20.



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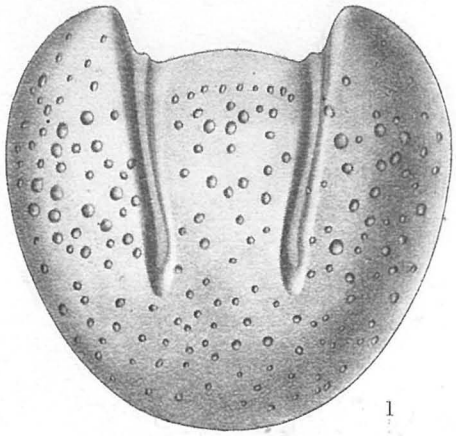

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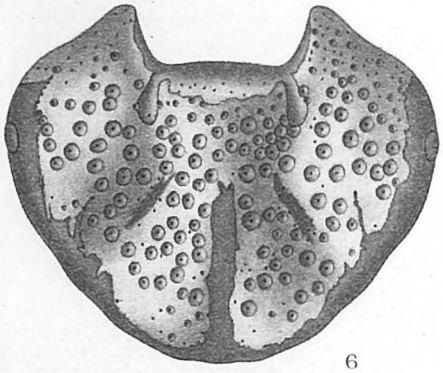

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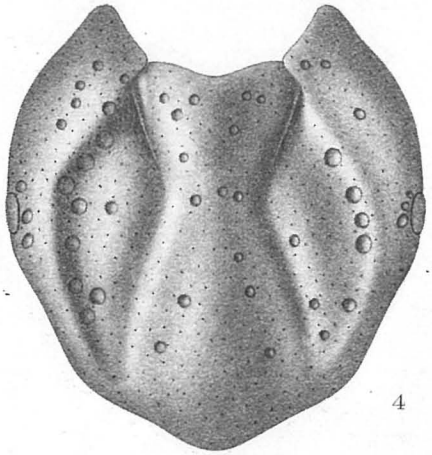

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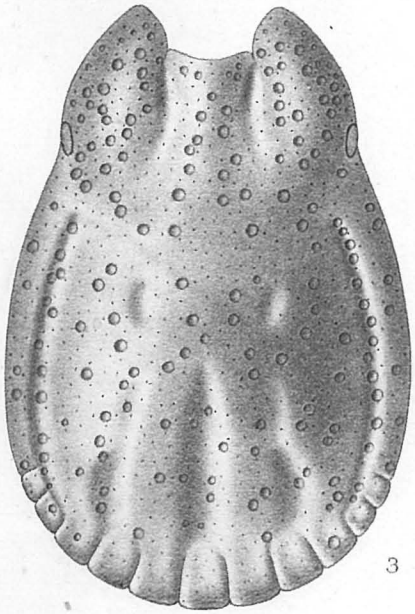

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INDIAN IXODIDAE.

EXPLANATION OF PLATE IX.

Dermacentor auratus Supino.

FIG. 1. Male, scutum : × 20.

Hyalomma (*Hyalomma*) *aegyptium* subsp. *isaaci*, nov.

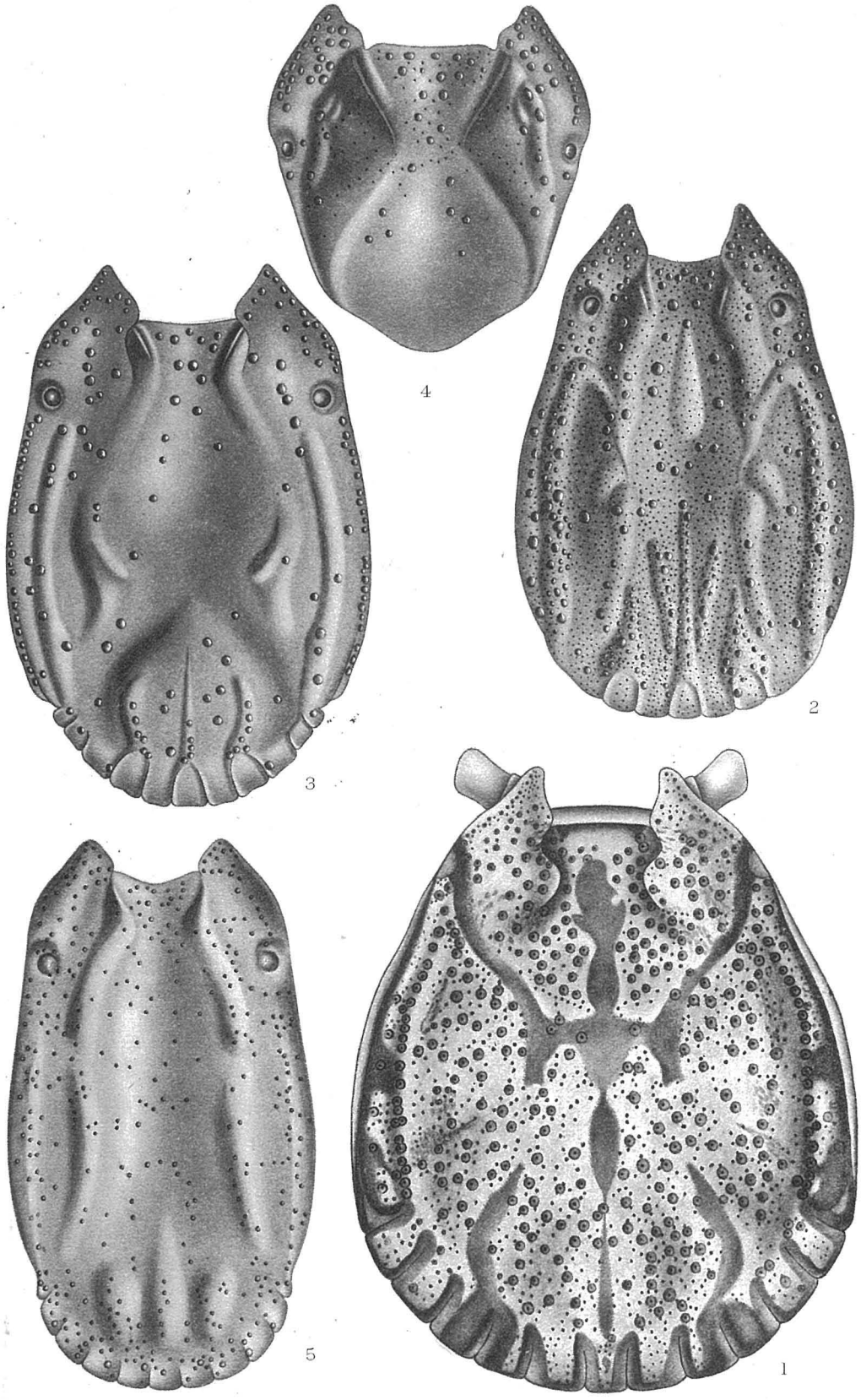
FIG. 2. Male, scutum : × 19.

Hyalomma (*Hyalommina*) *hussaini*, sp. nov.

FIG. 3. Male, scutum : × 30.
FIG. 4. Female, scutum : × 28.

Hyalomma (*Hyalommina*) *kumari*, sp. nov.

FIG. 5. Male, scutum : × 28.



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